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VOL. II, No. 1 MARCH, 1945

Education for What?*

By

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I have chosen this title to my address " Rural Education for What " so that I can have as free a field as is possible to develop two themes: (1) the structure of rural education from primary school to adult education, its difficulties and its advantage over urban, and (2) the general aims of education, and the special aims of education in rural areas.

The first thing to note in dealing with rural education is that the country as distinct from the town educates far more children in all civilized communities than it eventually keeps as adult workers. When we hear criticism about the extra expense of education in the country it is well to remember that fact; the town is continually enriched by immigration from the country, and moreover immigration by many of the brightest of the country people.

The census of 1933 shows that the number of dependent children in Australia in metropolitan areas per married man was 2, in smaller provincial towns 2·26, and in rural areas 2·47. It is not clear whether this last figure means strictly from farms. In other parts of the world there is a still bigger discrepancy; in fact in many countries there are two children per family in rural areas for every one in the town.

With the increasing productive power per individual consequent on scientific advance and mechanical achievement in agriculture, and the opening up of new areas and the intensification of agriculture in well-watered regions, there is no doubt that there will be a smaller and smaller proportion of people actually required to produce food and fibres as time goes on. Consequently a proportion of young country people will always face the problem of finding suitable employment away from the land.

The Structure of Rural Education.

In discussing rural education therefore we must cater both for the children who will remain on the land and for those who will seek professional or technical training for careers in the towns.

Education in a democracy should have certain common aims. These aims are first the three R's, so that all people shall be at least literate, second the stimulation

* Presidential address delivered at the Seventh General Meeting of the Australian Institute of Agricultural Science, Melbourne, 13th February, 1945.

of critical thinking so that all individuals will be intelligent voters, and third some introduction to the cultural, spiritual and intellectual heritage which represents the accumulated knowledge and wisdom of the particular culture in which we live.

The Primary School.

These aims are of equal value in any area, rural or urban, and if we accept the recommendations of the English Haddow Report they should be followed in all schools for children up to the age of eleven, at which age primary education is considered to have been completed. At that age rural young people, it is suggested, should be divided into two groups, those who are to remain in the country or in country towns to continue living on the land, and those who wish to seek higher academic education with a view to going on to the professions. In most civilized communities something like 10 per cent. of the community goes on to train for professions, while the remainder pursue technical training or the ordinary school training up to the age of fourteen, fifteen or sixteen.

For those in the country who seek professional training, country high schools on the ordinary academic lines are usually recommended but I suggest that it may be possible for them to get an equally valuable education by continuing for a longer period in rural schools of the central, or area, or village-college types, instead of going in for strictly formal academic work.

What are these central, area and village-college schools? The area schools in Tasmania have received so much publicity of late that, even without having been privileged to see them working, most of us have garnered an impression about the ideal behind them. The ideal is much the same as that behind the central school in some areas in England and is also rather like the ideal of the Cambridgeshire village college. After the child reaches the age of about eleven in these area schools, or general schools as we may call them, education moves away from the strictly academic type which is concerned with Mathematics, Languages, History, Geography and the Sciences as subjects, and concentrates rather on using the rural environment as its inspiration for further education. The project system is used for providing educational fare instead of the subject division of education. The whole school might embark on a project, for instance, to dramatize the development of the wool industry in Australia. Such a project would lead students into a study of geography, history, social and political theory, scientific fact in the fields of genetics, animal nutrition, agrostology and finally on to world trade and economics, and perhaps some reference to study the competition of artificial fibres. With such a training the students would get the habit of seeking facts for themselves under the stimulus of interest and the end result should be live learning instead of dead knowledge.

Higher Education.

A special point of interest to me is to see whether such an area school for rural children could be at the same time an ordinary high school dealing with those who wish to go on further with their academic work, and a school for all those who have no intention of going further. If we could get the land, the equipment and the animals necessary to the outside work, and if we could get the teachers suitably trained and with sufficient inspiration and breadth of vision to do the teaching, the general stimulus in such an environment would be such that the ordinary education, even in the academic subjects might quite easily keep pace with the academic education being taught in another and more formal environment.

Examinations should be completely banished from school work at this type of area or central school. Teachers will know better than I do how far some form of group tests should be given to determine the progress of students and how far the competitive spirit can safely be used without harm to students in urging them on to greater efforts. I have a certain sympathy with the idea exploited apparently in Russia in which the class is given a corporate pride and responsibility by making all

responsible to see that every member of the class reaches from time to time different stages of perfection in whatever subject they are pursuing.

The village college in England developed in Cambridgeshire is like the area school in Tasmania, with the same ideals, the central theme being to relate the life of the school to the life and practice of the community in which it works and to enrich the quality of life for the students rather than simply to increase the bulk of their knowledge. In addition to the ordinary function of rural school the village college caters for adult education and is a community centre giving medical attention as well as ordinary educational attention to its students.

For the ordinary education of the country child it seems that the promise for the future lies in those central schools fitted to the rural environment and staffed with teachers well trained in rural lore as well as in ordinary academic subjects.

It is reasonable to expect such rural schools would inculcate not only the experimental outlook, which is not afraid of change in a rapidly changing world, but an eagerness for continued education, and a love of the life of the land with all its variety, risk and interest. Not only should children learn something about the techniques for efficiency, but they should have the emotional environment which stresses the desirability of life on the land.

Present System.

The difficulty about our Australian countryside is that in so many places the rainfall is so light and the population so sparse that the number of children within a reasonable distance of a central school is always apt to be small. For the economical working and proper staffing of such a central school about 240 students would appear to be a minimum, and residential schools for everybody do not appear to be a practicable proposition yet.

Under our present system of education there is always a controversy about the one-teacher school as against the multiple-teacher school. There is a lot to be said in favour of the one-teacher school, if the teacher sent to the country is of high standard. It is however inevitable that the junior rather than the senior teachers should be sent to these one-teacher schools. It is beyond reason to expect the Education Department to send a highly trained and experienced teacher to deal with 10 or 20 children and yet, from an educational point of view, it would be well worth while. It is unlikely that one-teacher schools can be eliminated for a long time and in any case they have the special virtue that any good quality a single teacher may have, can be transmitted to the small number of pupils far better than in a larger school. The training of teachers for the one-teacher school is a matter for experts, but I feel strongly that any teacher going to the country should either have a background of rural experience or at least be given some training in natural history, climate, crops and plants, and generally the subjects that are of special interest to the country dweller. There is probably less danger of serious disability coming to the rural children through the one-teacher schools up to the age of eleven than there is in students remaining at the one-teacher school after that age.

If the scholars are to remain in the country, it is better that from 12 to 14, or 15, or 16 they should be in the central school of the type already mentioned, where there are more children of their own age to mix with, more teachers to come into contact with, and a bigger community to rub shoulders with, so that this sense of community, and feeling of responsibility within it, which is an essential part of the training of any good citizen, can be developed. In such a community, too, the democratic ideals of individual freedom with individual responsibility to that community can be developed.

Country children have the special advantage as compared with town children that they are real people dealing with real things. Urban communities naturally have more continual contacts with other people, and the children are, perhaps, more alert, with quicker minds, but they have less opportunity for thinking than the

country children. Country children tend to be a little bit more suspicious, and when presented with a problem are slower to tackle it, but can think more deeply about it than the town children. They have also a wide range of contact with animals, plants and machinery which gives them a range of emotional and material experience which serves as an ideal background for education, and is in fact part of education itself.

Specialized Training.

For the sons and daughters of farmers or others who wish to get higher technical training in agriculture there are the agricultural colleges and it is hoped increasing numbers of students will attend them. These colleges of agriculture have a bright future, particularly for students who are themselves going back on the land to be farmers. For the profession of agricultural scientist in research and extension work, however, the future lies rather with training at the universities.

In all technical courses and in university courses in agriculture there should be insistence not only on the scientific disciplines, Geology, Botany, Zoology, Chemistry, but also on the cultural values which give meaning to civilized life. For example, when Agricultural Chemistry is taught it should be linked up not only with practical problems in agriculture, so that it is related at all times to the rural environment, but that the history of chemistry should be built into the course. From the history of chemists and chemistry will naturally arise an interest in the history of the community in its social and political development. It seems to me that it is better to tie every science to the liberal arts in such a way that the student's interest springs from his central scientific study, but naturally expands into the field of human history and sociology rather than that the student should be taught for instance history as a subject, and botany as a subject, without the two being tied together in an intimate association. Interest in the liberal arts and so in civilized living should be made to spring from the central scientific interests of the students.

Adult Education.

There is one major phase of rural education which has not yet been touched upon, but which is nevertheless extremely important, that is adult education. Adult education depends for its success to quite a considerable extent on primary education. If we have been successful in inculcating a real desire for education at the elementary levels, then there will be a desire to continue that education into adult lives. The chief duty of all adult educators in rural areas is to bring to the country people an appreciation of the richness of opportunity not only for social living, but the wealth of material available to enrich the individual life of the person living in the country.

At the adult-education level there are formal studies in summer schools, at agricultural colleges and formal correspondence courses, and as well informal studies come from the radio, from farmers' ordinary experience and contacts, from libraries, from farmers' social and political organizations and so on.

It is desirable that there should be a considerable extension of adult-education activities in rural areas after the war, particularly if we can develop something which would fit our own cultural situation but contain the essential elements of the Danish folk high schools. These are residential schools to which people over eighteen can go either to continue to study some cultural subject which interests them and which they have been unable to study before, or purely technical, agricultural subjects, or subjects like economics, sociology and philosophy which demand a mature mind and some experience of the world before they can be fully appreciated.

Summer Schools. Judging by the enthusiasm shown at adult education summer schools and in training schools in army camps and elsewhere there would be many who would like to go for six months' residential experience in such schools if they could be established.

After the war too it should be possible to have huts at present used by the army transferred to the sea coast and made into summer schools for people from

the country. In these, from two weeks to two months could be enjoyed by farmers, their wives and sons and daughters in recreational activities, educational activities and cultural and technical studies.

Rural Libraries. Australia is poorly equipped with rural libraries, and though a good start has already been made in Tasmania and in New South Wales, a big extension is to be aimed at. That such a service would be appreciated is indicated by the popularity of the Adult Education Library in Western Australia. This is widely used throughout the State and in at least one farming district in Western Australia the rate of reading and the quality of literature taken from the local library is the same as at the figures given for England. In most of Australia, however, the reading rate and the quality of reading is very much lower.

Agricultural Extension Workers. The extension workers of the Departments of Agriculture throughout the Commonwealth are doing, and have before them, a tremendous job in adult education in rural areas. They can be the focal point for the intellectual activity of their own communities arising from the special interests of the farmers in their own farming activities. From that their efforts can be extended into social life, scientific interests and eventually into all the general interests of a civilized community.

Community centres are of greater importance in towns at the present moment than they can be in rural areas. Easy and rapid transport make the country people inclined to seek the metropolitan areas for their recreation rather than their local township.

The little experience I have had with adult education in Western Australia has shown me that once people get a taste for education it becomes in their adult life the central theme of their existence, and the same people come year after year to the summer camp and the same people belong year after year to the Box Study Scheme and patronize the various activities offered by the Adult Education Board. If this spirit could be spread throughout the community it would result in a continually improving standard of education amongst the people, so that an educated democracy might eventually become a real thing instead of only an ideal after which we are striving.

The Purpose of Education.

Up to the present I have been speaking of education in various institutions and have not dealt at any length with *'education for what?'* The end point of all education which is provided by a State is to produce citizens of that State who will contribute at their fullest capacity to the well-being, material and spiritual, of the State. In a democracy the underlying intention is to produce citizens who will have minds sufficiently free and courageous to operate successfully in the unstable equilibrium which is the very essence of democracy and which permits of continual progress, and continual adjustment of democratic institutions to change.

Avoid the Failures of Education.

A psychiatrist, addressing teachers recently in the United States, made some extraordinarily apt observations about the failure of the educational system in certain directions. He said amongst other things that one of the commonest attitudes which children get from their parents and which education fails to remove is the fear of change. In the type of progressive area school suggested for the country it should be possible to inculcate an experimental attitude so that this progress-clogging fear of change which is rather common in the country need not be developed or stimulated.

He observed further that the individual in a democracy was apt to feel a frustration because of his ineffectiveness to alter the things he saw to be wrong in our complex civilization. Our education should strain every nerve to remove this

feeling. Education should lay stress on the power of the individual in democracy not only to contribute to the institutions in which his economic and social life are given form but to assist in altering them to conform to new knowledge and new standards.

His next challenge was that the education system produced people without internal resources so that they are unhappy unless they are being deliberately entertained or are busy earning a living. This challenge I think is not so true of the country as it is of the city. The countryman has a deep satisfaction arising from his feeling of doing real things and producing essential things for the world's well-being, and this saves him from that particular bankruptcy, but there is no doubt that better education could contribute more than it does to his inner resources.

His last challenge was that modern civilization, particularly in democracies, lacked a faith for living and a strong loyalty to some set of principles. In this world which science has made atomistic, there is obviously justice in his challenge, but again the country, I think, has less to fear than the town. There is a definite loyalty to the everlasting soil, and rural people see a more obvious, causal relation between things than the urban population can see.

Community Economic and Political Interests.

The second aim could be considered in relation to the farmer as a member of the farming community and as an economic unit and a political force. In order to possess economic and political effectiveness the rural population must be aware of the value to the community at large of the goods they produce, the special value these goods may have in international markets, and as political entities the country people should have a keen awareness of the relation of economics in the country to the economics of the whole community.

The farmer cannot be an effective member of his local farmers' organization, nor of his electorate, unless he has at the same time some knowledge of local and international affairs and an awareness of his own responsibility as a unit in an organic democratic State. Producing food as he does, he should be more keenly aware than the city dweller of the need to raise nutritional standards throughout the world so that he should be internationally minded as well as nationally. The farmers, of all people, should press for the recommendations of the Hot Springs nutrition conference to be put into effect.

We should educate our rural population to make them good citizens of a world in which an economy of plenty instead of an economy of scarcity is the ideal. They should see from their own experience of science applied to agriculture how science itself has made an economy of abundance possible and should do everything in their power to work towards that end.

The tremendous experiment represented by the work of the Tennessee Valley Authority has a lesson for democracy which could well be applied in the life of our countryside. That experiment has shown that democracy is capable of having a conception greater than any single enterprise within it, and of carrying to completion with the aid of scientists and other experts projects greater than any single unit of private enterprise could possibly imagine. The shackles of private enterprise lie in their single aim of profits. T.V.A. has shown that within a framework of planning in the interests of the whole community, private enterprise can function satisfactorily and effectively. The main point is that the overriding planning must be done by the community for community ends, but within that plan private enterprise with the necessary restrictions, which have to be put upon it in the interests of the community, can operate satisfactorily.

In Australia the Lands Departments represent something of the functions allotted to the T.V.A. in America, and in some of their developmental schemes they have done great things. The Irrigation and Afforestation Commissions have been

very successful, but it does appear to one, in view of the nation-wide cry about soil erosion and the necessity to conserve our permanent asset, the soil, that we have not yet been able to develop an organization for all-over planning to conserve and exploit our soil resources in the best interests of the whole community. It appears that the genius of the Australian people has not yet been brought to a focus by any organization or by any government in such a way that the rural resources of the Commonwealth can be developed to their fullest extent and the soil not only conserve but improved. Surely it is to the country people themselves that we must look for a lead in the future and only through a highly educated country community can such ideals become realities.

Conclusions.

Farming is not only one of the oldest of the activities of man but the soil is the only asset which is everlasting and which can be improved by use instead of being dissipated. It is no mean objective that the education of the countryman should aim at making him effective as a farmer, effective as an individual with the right spirit, a free outlook and a cultured mind, effective as an international co-operator, making his contribution to the rising standards of the whole world, and effective as a man living a life satisfactory to himself and his neighbours, and anybody connected with that education can never feel that his work is done.

I would sum up then that rural education in its ultimate aim should be directed towards liberating the free spirit and the inherent genius of the countryman, in the hope and belief that he has in his way of life and his natural assets the capacity not only to make the countryside flourish, but also to give the whole Australian community a new grip on reality and a new vision of the possibilities and satisfactions of civilized living in an age when science has made a world-wide economy of abundance possible, and only the clumsiness and selfishness of man hold back its coming.

It is hardly necessary for me in ending this address to say that the members of this Institute, whose own opportunities for education and wide experience in all branches of agriculture are outstanding, must play a leading rôle in helping by their words and works to accomplish the ideals and reach the aims which have been the subject of this address.

(Received for publication, 14th February, 1945.)

The Third Report of the Rural Reconstruction Commission

LAND UTILIZATION AND FARM SETTLEMENT

The Third Report of the Rural Reconstruction Commission is devoted to a discussion of the principles underlying proper land use in Australia. It deals with the physical factors of the environment (climate, soil, and topography) and discusses how they can be assessed, the manner in which they influence proper land use, and their interpretation in terms of Government policy. Other factors discussed are markets, geographic location and public works, while in the final chapter land settlement policy, especially in relation to proper land use, is reviewed.

The recommendations are of diverse character but relate throughout to the need to prevent abuse of our rural resources and to take steps both to conserve and build them in future decades. Co-ordination of land use, maintenance of soil fertility and prevention of erosion are recognized as major phases of this problem and the attitude of the Commission in all instances is that there is a national as well as an individual responsibility to prevent misuse of land and loss of fertility.

One of the principal recommendations is that a Land Utilization Council be established in each State to co-ordinate policy in the allocation of land for farming, forest development, water resources, national parks and reserves. There is no doubt that such a Council could be of the greatest value in ensuring the most desirable use of land provided the State Government were prepared to make it mandatory on all authorities concerned to accept the findings of the Council. Unless State Governments accept this recommendation in spirit as well as in letter and give adequate powers to the Council, it may well become " just another committee ". An extension of the function of such a body beyond the terms proposed by the report might ultimately be envisaged. Thus, such a body might prevent the use of land for a *particular* agricultural purpose even though the area had been allocated for agriculture.

National responsibility is stressed particularly in regard to soil erosion. " No individual . . . should be permitted either wilfully or through ignorance to use land in such a way as to render it liable to erosion." The Commission refrains, however, from recommending specific means of achieving this objective and the recommendations on soil erosion are disappointingly modest compared with the tenor and extent of the text. It advises the establishment of a soil conservation organization in each State, and better credit terms for the purpose of approved conservation work. With the lead given by the United States in soil conservation the views of the Commission on the applicability to Australia of the principal phases of the American approach would have been of great interest, but the discussion of this subject is largely confined to the cause, character and extent of erosion in Australia rather than to the administrative, legislative and technical measures needed for control. Thus when consideration is given by agricultural administrators to the problem of combating soil erosion, they will almost certainly find it necessary to go far beyond the recommendations made by the Commission.*

* The Australian Agricultural Council decided on 24th February, 1945, that the general work of soil conservation should be handled by State organizations. Further, that the Commonwealth should assist the States in aspects of soil conservation dealing with the co-ordination of the work of the States, co-operation and assistance from trained personnel and, in consultation or collaboration with the States, special research projects. It decided that co-ordination should be achieved by the establishment of a Standing Committee on Soil Conservation, comprising Commonwealth and State representatives.

The broad question of the maintenance of soil fertility is similarly dealt with at considerable length in the report, but the recommendation is confined to the need to bring an advisory service to every farmer. While the education of the farmer is undoubtedly of major importance in the approach to the problem of fertility maintenance, the possibilities of administrative and legislative action must again surely be considered as a phase of the problem. The operations of the Agricultural Adjustment Administration in the United States provide an outstanding example of effective action by this means. Such legislation, designed to encourage fertility maintenance, has had a remarkable influence on American agriculture in the past ten years.

At a time when land settlement looms largely in the public mind, particularly as a means of rehabilitation of returned soldiers, the note of warning sounded by the Commission on closer settlement policy is opportune. It stresses the post-war dependence of Australia on export markets, even though migration proceed at an annual rate of up to 100,000 persons or if nutrition standards in Australia be raised to near optimum. Any land development scheme should thus be based on long-term prospects for the disposal of the product, prospects which can be determined only by survey. Land settlement for its own sake can prove a dangerous policy. This applies particularly in the immediate post-war period when inflated prices for primary products may tempt both politicians and prospective settlers to press for schemes which will fail to survive the return to more normal market conditions.

The fundamental change in the viewpoint on land settlement since the last war is illustrated also in the Commission's recommendation that no new settlement be undertaken if the more intensive use of areas already settled will provide the additional farm produce required. This contrasts vividly with the schemes following World War I, which sought to develop new productive units on areas in which soil and climatic suitability for the proposed venture were frequently almost unknown. As a means to the more intensive development of existing estates, the Commission is emphatic in its belief that power for compulsory acquisition of land must be taken by statute. This recommendation will certainly be acclaimed by agriculturists familiar with the contrast of struggling marginal farmers on the one hand and under-developed estates on the other.

A further important aspect of land settlement is the question of the area to be allotted to the settler. Briefly, it is proposed that the area of the property should not be the area required to maintain an average family, but the area which will lead to the greatest farming efficiency in the district under consideration. Again this viewpoint is in sharp distinction to the principles adopted in land settlement after the last war and if accepted by Governments and administrators will add enormously to the chances of success of post-war settlement schemes.

The Commission covers many other phases of land use such as alternative forms of land settlement, land valuation, mapping services and the need for both extensive and intensive study of climate and soil. Each aspect of the wide field traversed in the report is discussed at length and the Commission has not hesitated to include full accounts of technical aspects and reviews which are educational statements rather than concise expositions of a viewpoint. The result is a lengthy document which tends to assume the tone of a text book and thereby to lose in forcefulness. Indeed, the discussion is so full and the recommendations so numerous as to leave the reader with an uncertain impression of the principal findings of the Commission. Many of the recommendations are not in a form outlining or even stimulating immediate administrative action, and much will remain to be done to interpret the Commission's findings into a form on which action can be taken.

Inevitably many of the recommendations depend on the promotion of agreement on policy between the Commonwealth and the States. The Commission is fully alive to the " parochial influence " which has operated between States in the history

of land settlement and the successful adoption of many of the recommendations will depend on readiness by Commonwealth and State politicians and administrators to collaborate in the creation of a national land policy.

The following notes summarize the contents and recommendations of the report:

Climatic Factors and Land Use.

Climatic Studies.

The Commission emphasizes the close relationship between climatic factors and proper land use. Rainfall has all too frequently been used in Australia as a single criterion in assessing the suitability of a region for particular agricultural purposes, but a more scientific assessment of climate is needed. Rainfall and evaporation should always be considered conjointly and the Commission commends the approach of the Waite Research Institute, Adelaide, where the monthly ratio of rainfall to evaporation has been adopted as a basis for the determination of agro-climatic zones. The influence of temperature during the growing season will in turn exert a major influence in determining the crops that can be grown. Correct land use within an agro-climatic zone will be modified by many factors, such as the availability of irrigation or sub-terranean water, the root systems of the plants under consideration, the soil types within the zone, and the occurrence of hot dry winds, hail, etc. There is extensive scope in Australia for detailed study of climatic data in relation to present and future agricultural developments.

Much can be gained by the study of plant homoclimes, i.e. of regions overseas of like climate to those of particular parts of Australia. Such studies will indicate the conditions under which particular crops can be successfully grown or, conversely, the species with which further investigational work might be undertaken in an Australian agro-climatic zone. Examples are quoted of homoclimes already recognized; for example, Townsville is a homoclime of Calcutta, and Brisbane of Durban.

The Commission stresses that Australia must be reconciled to the fact that more than 80 per cent. of its land surface is not likely to be suited to cropping except under irrigation. The prospects of breeding crop species for use in these areas must be accepted as being remote. There remains, however, scope for the introduction of useful pasture species from homoclimal regions into many of our drier areas.

Climatic Variability.

Variability of climate must be recognized as a major factor affecting the success of agriculture. An illustration is drawn from the Victorian mallee, where the variability in wheat yields of particular counties shows a high correlation with the variability in the rainfall. High climatic variability and high variability in crop yields mean that the farmer will be over-capitalized if he has sufficient equipment to handle the big crops in good years; that in drought years he has to carry all overheads and expenses without return; and that following a drought period the re-stocking of his property may be necessary at a time when stock values are abnormally high. Costs of production vary tremendously from year to year and the farmer himself suffers psychologically as a result of frequent crop failures.

The Commission therefore recommends that farmers with limited capital should not be encouraged to go into regions with high variability of rainfall; that only men who have had experience in such areas should be allowed to take up holdings in these districts; and that extreme caution should be exercised in subdividing land to ensure that holdings are of a size which will attract men with capital and which will permit of a scale of operations allowing an adequate margin to cope with varying incomes caused by fluctuating seasonal conditions.

Agro-climatic Service.

The Commission stresses the need for an effective agro-climatic service able to study climatic data in connection with land use, including such aspects as run-off; frost, thunderstorm or hail-stone risk; reliability of harvest weather; determination of homoclimes; scientific crop forecasting; relationship of climate to disease and insect pests, etc. It therefore recommends that such an agro-climatic service be established, consisting of highly-trained men with a knowledge of statistical methods, agricultural practices, and plant behaviour. The senior men in this service must have adequate status. The Commonwealth should assist any State willing but unable to establish such a service.

Insurance.

Insurance against climatic variability is difficult because of the wide variability in premiums which would be needed according to the drought frequency of the different districts affected. Even within a district, the good farmer might object to paying premiums if he enjoyed only the same cover as his less efficient neighbours. For the livestock industries, the proper method of drought insurance is by the adoption of a general policy of storing reserves of fodder.

Irrigation is the most obvious device for overcoming the disability of low and uncertain rainfall. In general, there has been a tendency to use irrigated land in low rainfall areas—not to mitigate the effects of drought by fodder production and conservation—but for such

purposes as fat lamb raising, orcharding, and dairying. This has arisen because of the need to cover the high capital costs by devoting the land to intensive production, and because the annual conservation of fodder, especially during a run of good seasons, involves heavier locking-up of capital than many primary producers are able to undertake. The Commission stresses the need to make use of irrigation in intermediate or outback areas for protection against stock losses. It recommends that the C.S.I.R. should collaborate with the States in setting up irrigation projects to study the methods and economics of producing and conserving drought feed in outback pastoral areas.

Soil Factors and Topography as Determinants of Land Use.

Soil Surveys.

Within any climatic zone the effect of soil may be of great importance, and many familiar instances are known in which crop success can be shown to be closely related to soil type. Relatively little information has been collected in Australia on our soils, or the relationship of individual types of soils to particular crops, pasture plants or trees. There is a pressing need for a service able to undertake both extensive and intensive soil surveys and to conduct investigations into such aspects as the deficiency of trace-elements.

The Commission recommends that detailed soil surveys should continue to be made, especially where development entails considerable investment per acre or where special problems of scientific or other interest are involved, and that more rapid reconnaissance soil surveys should be made in all areas within the climatic zones suitable for the extension of farming. Where the Commonwealth has an interest in the development of any area this work should be a Commonwealth responsibility allocated to C.S.I.R., and in other cases should be a State responsibility assisted where necessary by the Commonwealth. It is recommended that all surveys should be carried out and recorded in accordance with the bases accepted by Australian soil technologists, and that soil surveys should be co-ordinated with the general scheme of topographic mapping in the State concerned. Each State should be provided with a well-equipped soil laboratory. Distinction is possible between failures due to remediable and those due to irremediable soil defects, and while farms on the latter soils should be treated as marginal cases for adjustment, experience in the past twenty years in correcting remediable soil defects is sufficiently encouraging to warrant a considerable development in this direction.

Soil Fertility.

The Commission deals at some length with the important subject of the maintenance of soil fertility. It points out that in Australia and other young countries, systems of farming which maintain soil fertility have been developed only infrequently. In many instances, the virgin fertility, either physical or chemical, has already been lost. "The problem of devising and adopting systems of agriculture which will maintain soil fertility and promote stable methods of farming is the key problem of vast tracts of our countryside in the better rainfall zone. This statement is true of that rather large part of our farm land on soils which are not naturally very fertile." Unfortunately there is not a general realization among farmers of the decline in fertility which is occurring on their properties. Several examples are quoted of soil decline, such as the development of phosphate deficiency in southern Australia, the development of copper deficiency on Western Australian pastures, the decline in fertility on the Atherton tablelands due to continued maize cropping, and soil exhaustion by over-grazing by both cattle and sheep. The Commission stresses, however, that many areas of farming land, seriously depleted in fertility, could be restored by a proper system of cropping to a much improved level of fertility. Few statistical data are available on trends in soil fertility, but the statistical demonstration of downward trends in wheat yields in many parts of South Australia, and of fertility decline under wheat-fallow or wheat-oats-fallow rotations in Victoria show clearly that crop data support field observations. Recognizing the necessity for steps to be taken to encourage the adoption of systems of cropping designed to restore soil fertility, the Commission recommends "the appointment of well-trained technical staffs sufficient in number for the task of bringing an advisory service to every farm". Farmers must be educated to welcome the advice provided, and must be given the assistance, financial or otherwise, to enable the adoption of such advice.

Soil Erosion.

The Commission deliberately approached the question of soil erosion with a completely open mind, but became convinced that official statements on soil erosion are not exaggerated. The people of Australia as a whole do not realize the extent of the menace of soil erosion, the need for drastic action within the next decade or the inevitable spread of erosion unless better methods of land use are adopted. The various forms of erosion are reviewed in some detail and evidence from each of the States on the extent of erosion is quoted. In N.S.W. some 50 per cent., or approximately 60 million acres of land, in the eastern and central divisions of the State, for the most part of high fertility and in moderate to good rainfall areas, are suffering actively from erosion. In Victoria, soil erosion is considered by the Soil Conservation Board to be a major problem throughout the greater part of the State. In South Australia all districts in the State with the exception perhaps of the south-east, are more or less adversely affected, while in Western

Australia a questionnaire survey of 373 farms showed that no less than 257 were suffering some degree of water erosion and 254 some degree of wind erosion. " The Commission takes the view that the nation cannot permit any individual or generation of individuals to use any land in such a way as to damage it irreparably. We believe that the holding of land is in a sense a trust for posterity and that no individual or corporation, no matter what their title or ownership may be, should be permitted either wilfully or through ignorance to use land in such a way as to render it liable to erosion."

Following a brief review of the present administration of the control of erosion in Australia, the Commission " earnestly recommends that each State should establish a special soil conservation administration with specialized staff. The details, of necessity, will be adjusted to the particular needs of each State, but it is in general recommended that this conservation organization should work in close co-operation with the Lands, Agriculture, Forests, Irrigation and Water Supply administrations and with any other authority concerned with land utilization ". "It further recommends that there should be adequate Cabinet support for the conservation authority ; and that where existing mortgagees will not extend credit for extension work, money should be advanced by the Government and that such an advance should be made a first charge on the property.

Mapping.

The need to determine land use potential by proper surveys and the dependence of such surveys on the availability of adequate maps is stressed. No satisfactory cartographic survey of Australia has yet been completed, though such data are of immediate concern to the Commonwealth for defence and development, and to the States for land use research and administration. No scientific plan of land use can be formulated or implemented until a proper classification and inventory of land according to its potential productivity, based on climate risks, water resources, soils and topography, has been achieved.

The Commission therefore recommends that the Commonwealth and States should co-operate in a mapping service, including basic triangulation, aerial and cartographic survey, and that the States should proceed with a proper classification and inventory of lands according to the physical and other factors which govern productivity.

Other Factors of Importance in Determining Land Use Policy.

Co-ordination of Land Use.

It is essential that there be a proper co-ordination between land use and long-term national needs. There are frequent instances in Australia in which wrong use has been made of land and this is notably the case with respect to many areas originally under forest. In the absence of any scheme for the purchase and subdivision of estates already settled, settlers had to turn to land still in the possession of the Crown, and this was mainly forest. Political pressure, backed by the prevalent viewpoint that land development was synonymous with the clearing of forest and that Australian forest species were of limited value for timber, led to many instances of good forest being destroyed to provide farming land, on which reversion to bracken, scrub or inferior forest cover could not readily be prevented. The remaining forest must be preserved.

Similarly a definite policy is needed in respect to national parks and recreation reserves, and principles are enumerated for the proper administration of these areas—namely that the management should conform to that of the catchment area of which the reserve forms part ; that erosion be kept to a minimum ; that timber cutting and grazing be properly controlled, and that fires be prevented.

The Commission takes the view that there must be no further delay in developing a national policy of land allocation and land usage. Such allocation of land to agriculture, reserves, national parks, catchments and forests, and the co-ordination and control of land use, is a function for State Governments, though the Commonwealth will be concerned in such aspects as the future timber supplies of Australia and satisfactory irrigation development. The Commission considers the problem of land use to be of such importance as to warrant the establishment in each State of a Land Utilization Council under the control of the Premier, this Council to have the task of co-ordinating State policy on all phases of land use concerning the allocation of land for farming, forest development, water resources, national parks and reserves, and erosion control. It recommends that the Council should consist of the heads of the Departments of Agriculture, Forests, Lands and Survey and Water Supply, and that it should be provided with a small expert staff capable of investigating any proposals submitted.

Market Prospects.

There is a common and dangerous tendency among the public to think of settlement promotion only in terms of land resources and the physical capacity to produce. Frequent representations were made to the Commission regarding the production potential of a particular area, with no other criterion for evaluating a developmental scheme than the increased production anticipated. Development based on this philosophy can lead all too easily to over-production and a decline in prices below a payable figure, as has been shown in the years since the last war. " The proper way (of development) is through the promotion of those things which give rise to

increased requirements, e.g. greater population, full employment, better nutritional requirements, expanding overseas trade, and greater efficiency." That is to say the development of increased demands should be the stimulating force leading to the further development of land settlement. The Commission recommends that any policy of development of resources and land should be preceded and conditioned by a proper survey of requirements in terms of long-range market prospects, both domestic and overseas.

Each of the factors which might give rise to increased demands for rural products is examined.

An attempt is made to assess the probable size of the Australian population in 1950 and 1960. Estimates of a population of 7,561,000 in 1950 and 7,924,000 in 1960, without loss or gain by migration during the intervening period, are adopted (G. R. Bruns. Econ. Rec., Dec., 1943). The Commission deduces that these increases in population would require 12,409 additional man units of rural labour in 1950 and 20,905 additional man units in 1960. If immigration proceeds from 1947 onwards at the annual rate of 20,000 persons or 100,000 persons respectively, the number of additional man units required by 1960 would be raised to 29,260 and 62,691 respectively. The smallness of these numbers will no doubt surprise many.

The Commission depends for its views on standards of nutrition largely on the reports of the Nutrition Committee of the Australian National Health and Medical Research Council. In order to bring nutrition levels to a satisfactory scale surprisingly few man units of rural labour would be needed. For example, 10,000 man units of labour on moderately efficient dairy farms would produce the quantity of milk needed to bring the per capita consumption to the satisfactory level of 2½ pts. per week. Similarly, 1,000 producers would produce the additional citrus fruit required, while relatively small numbers would, on mass production lines, provide the additional vegetables needed. However, in view of the importance of the home market the Commission recommends that steps be taken to stimulate a better standard of nutrition among the Australian people by educational and other means, and especially to secure a wider distribution of milk and milk products, citrus fruit, fresh fruit and vegetables.

Thus, the Commission is forced to the conclusion that neither expanding population nor improved nutritional standards provide opportunity for any great expansion of the farming industries and that the export markets " will remain as significant for most forms of Australian agriculture in the post-war world as they were in the years prior to 1939." Accordingly, it recommends that the Commonwealth should take all steps in its power to further the expansion of such trade.

The Commission then proceeds to review the prospects for increased international trade. " If the prospect is to be based on the experience of the immediate past, the future is a black one ; for although there will certainly be a wide demand for certain types of foods as soon as the war is over, this will cease rapidly with the reinstatement of agriculture in devastated lands. If, however, a wide view is taken and the international trade is rebuilt upon more secure foundations, there may well be increased markets for certain of our agricultural products." Extensive reference is made to the report of the United Nations Conference on Food and Agriculture held at Hot Springs in 1943. That conference stressed the need for adequate nutrition of all people and particularly the responsibility of each nation to see that its own people have the food needed for life and health. Desirable changes in the pattern of production, designed to give greater emphasis to foods rich in vitamins, minerals and proteins, should be fostered, with a corresponding reduction in the production of bulky energy foods in those countries in which such foods cannot be efficiently produced. It calls for a rationalization of world agriculture. The Commission expresses hope that such a bold international policy may be capable of achievement and adds that without the prospect for increased international exchange of foods, there is no reason to encourage an expansion of the main lines of production of Australian agriculture.

A most important viewpoint expressed by the Commission is that the rural industries must not be looked to for the absorption of the majority of migrants. No more than 12·5 per cent. of any immigrants can be expected to find a place in agriculture without repeating the experiences of 1925-35. " If it is the desire of the Governments to repress standards of living on farms, then there can be no more certain method of doing so than by encouraging land settlement without a reasonable expectation of an increase in the satisfactory permanent markets for agricultural produce."

Geographic Location.

The influence of geographic location on costs of production and on the availability of markets is discussed and reference is made to the question of establishment or continuance of processing works at country centres. Many such works have commenced during the war with a consequent opening of new lines of production to farmers of the district. However, unless such works are able to continue on an economical basis in the post-war years they should be closed down. Their success or failure will depend on such factors as the continuity of supplies for processing, the efficiency of management, the loyalty of the suppliers, the market for the product, and in some instances the provision of refrigerated cars on the railways. Many thousands of pounds can be lost in an endeavour to keep processing works in operation when their chances of success have already proved themselves to be slender.

Public Works and Land Use.

A well-defined policy is needed in regard to public works affecting land use. In past years the viewpoint held by Governments was that any developmental work should, whenever feasible, eventually be paid for through charges levied on those who benefited therefrom. This viewpoint now tends to be superseded by the realization that the State, by expending money on public works, may reap indirect benefits through the increased volume of production and that the policy of endeavouring to recoup State expenditure on public works may frequently be short-sighted. Careful planning is needed in the public works programme and the Commission suggests that any proposed public work in the countryside should be examined both from the viewpoint of its effect on the land use of the region concerned and its financial background. In determining the relation to land use there is need for the closest co-ordination of rural public works between the States. For example, if several States establish irrigation areas based on growing vines for dried fruit, overseas markets for that product might be completely dislocated by the sudden increase in the volume of production. The Commission recommends, therefore, that policies for rural public works throughout the Commonwealth should be co-ordinated to ensure that productive capacity is correlated with market demands. So far as works in country areas are concerned, the Commission recommends that consideration should be given to the provision of extra facilities for present rural dwellers rather than the extension of settlement which might be uneconomic.

The provision of amenities in country areas might, in many instances, reasonably be regarded as warranting the expenditure of non-recoverable public funds, either as a means of avoiding waste of manpower (i.e. education and medical services) or as a subsidy to remove some of the disabilities suffered in country life.

Land Settlement Policy.

New Settlement.

A sound agricultural policy will seek to satisfy requirements by locating production where resources offer the best returns and the best prospects. Production should not be obstructed from extending to new areas, or by failure to make full use of favourable areas already settled. Conversely high cost areas should be progressively eliminated or modified (as is being done in marginal wheat areas) though social implications may make this process slow and difficult. An increase in the demand for any product should be used cautiously as a basis for new settlement, since temporarily increased demands or high prices may easily lead to bringing into production land which is unable to produce profitable crops in periods of normal demand.

The Commission therefore recommends that agricultural policy should be directed towards a progressive improvement in the location of production by elimination of areas of high cost production and, as opportunity offers, extension of production in more favourable areas. In general new lands should be opened for settlement only when increased agricultural requirements cannot be economically met by more intensive use of already settled areas. In some instances, however, it may be desirable to develop and settle new areas largely for defence reasons.

Closer Settlement.

There is a constant pressure for the subdivision of settled estates. The unsatisfactory returns to the wage earner in most rural industries ; the freedom from interference, continuity of existence and security of savings provided by land ownership ; and the possibility of speculative profits are the principal reasons why people are anxious to acquire land.

In assessing the value of a particular subdivisional scheme it is essential that a thorough scientific survey of the climate and soil should indicate that the chances of success are good. Where it is known that certain practices are needed to build soil fertility, settlement should be based on conditions which prescribe that those practices should be followed. If capitalization costs are high the Government should be prepared to assist in bearing those costs especially if the settlement is being carried out for strategic reasons. Areas in which rainfall is low and highly variable are not suitable for closer settlement for agricultural purposes and in the case of grazing districts it is essential that the men be experienced with that type of climate, that the area allotted be adequate, and that over-grazing be subject to penalty.

The Commission recommends that the Commonwealth should endeavour to promote agreement with and between the States for the adoption of general principles of closer settlement policy. It is stressed that closer settlement should be embarked upon only where it is necessary to put land to higher and more intensive uses, such as dairying or fattening instead of the production of wool or store sheep. Subdivision purely because estates are large, without any change in the type of land use, is likely to lead to heavy increase in capitalization and, in some instances, to lowered efficiency. Demands for land should be discountenanced when they are inconsistent with the foregoing principle of closer settlement. It is further recommended that power to take land compulsorily for purposes of closer settlement should be created by statute, since the Commission believes that private ownership of land should never become a perpetual, inalienable right, but should be subject to exercise by the State of its powers in the public interest. Compensation for compulsorily acquired land should be based on the fair market value, having reference to the purposes to which the owner was putting the land during the five years

immediately prior to the notice of resumption, and not to the potential value for the more intensive purposes for which the land could be used.

Farm Size.

Inadequate farm size has been a principal cause of failure in many closer settlement schemes. The areas adopted were determined without adequate information on the characteristics and capabilities of the land to be subdivided and without distinction between a short term trend of high prices and longer term prospects. In some instances there was an endeavour to settle a maximum number of men on a fixed total area, while the authorities frequently lacked knowledge of the farming methods which had to be adopted if soil fertility was to be maintained.

The small one-man farm suffers disabilities under modern agricultural methods. The farmer cannot afford to adopt highly mechanized methods because of the excessive capital costs involved, and thus is faced with higher costs of production. The inefficiency of small units producing goods at high cost leads to mass demands for increased prices to be paid for goods produced.

Thus there is a clash of ideals between the political viewpoint based on a maximum number of settlers each with a living area and the economic viewpoint.

The Commission recommends that the concepts of " home maintenance area " and " living area " as determinants of the proper size of farms be discouraged, and that these terms be used to illustrate the minimum rather than the optimum size. It is recommended that as a standard for the promotion of healthy settlement the following criterion of optimum area be adopted : " the area which, when used for the purposes for which it is best suited under a long-range production programme, with due regard to proper farming and soil conservation methods, and when worked with average ability, permits the employment with the least waste of those combined factors of production which make for the greatest efficiency, and is capable of producing an average net income or equivalent thereof not less than is sufficient to maintain those who work it at a level in conformity with Australian standards of living ".

It is essential that opportunity for economic progress be open to the individual by acquisition of additional land. Unless this is so, and if the " home maintenance viewpoint " is adopted, then the opportunity for economic advancement by the efficient farmer is severely limited. It is therefore recommended that no obstruction should be placed in the way of a farmer who acquires or desires to acquire an area greater than the standard area and that legislation be amended accordingly. It is not feared that any danger of land monopoly will be created by this policy, especially if provision is made for the resumption of areas not kept in a high state of production.

Alternative Forms of Settlement.

The Commission recommends that State farming, collective farming and communal settlement should not be adopted or promoted by the States, but that the latter two should be left to voluntary organization where any body of settlers desires to undertake such forms of settlement. Co-operative farming, whereby individual ownership of farm units is maintained, with the owners pooling all or part of their labour, plant or machinery and allotting it out for work on the individual farms, should be given every encouragement under voluntary organization, but settlement policy should not cut up land into small units that can be farmed successfully only on a co-operative basis.

The advantages and disadvantages of share farming are reviewed and the Commission accepts the fact that share farming on a proper basis provides a means whereby industrious farm workers can accumulate the necessary capital to achieve ownership. There is, however, a need for effective control of share agreements and every share farming agreement should be registered with an appropriate local authority. Appropriate forms of agreement setting out, not only the contribution by each party and the ratio of division of the proceeds but also details of the farm procedure to be adopted, should be available at low cost. A division of proceeds more favourable to the share farmer is recommended.

Finance for Settlement Promotion.

Heavy losses have been experienced in all States under closer settlement schemes. These have been due principally to the false conception that men with no capital could be started off with a 100 per cent. liability at normal interest rates and be expected to pay their way. An apathetic spirit towards obligations grew among settlers, owing to the delay on the part of the States in making the necessary adjustment to the contracts. These are inherent weaknesses in the system under which the relation of lender and purchaser has been maintained between the State and individual. In many instances the settler had three, four, or more accounts with various Government agencies. It is recommended, that in order to avoid direct financial relations between the Crown and settlers in any scheme of land development, the State's relations be confined to the provision of the necessary finance to an independent agricultural credit organization. This organization would finance the settlers on conditions defined by the States, for all purposes, including acquisition and improvement of land, purchase of plant, machinery, stock, etc. The Agricultural Bank of Tasmania is quoted as a satisfactory type of credit intermediary between the Crown and the individual settler.

Settlement Policy in the Transition Period.

The Commission draws attention to the inherent dangers of land settlement schemes during the inflationary period likely to follow the war. It recommends that wherever possible increased production for short term requirements should be sought from existing farms rather than by the establishment of new farm units. No settlement other than soldier settlement should be brought into existence during the transition period, and soldier settlement should be concentrated into forms of production which have established permanent markets. Control of land prices and terms of lease will be essential for a period of not less than five years after the war to prevent undue increases in land and land speculation, and to facilitate the acquisition of land for returned soldiers at a proper valuation. The value of the land as at 1st September, 1939, should be adopted as a basis in the acquisition of land for soldier settlement.

Land Valuation.

The lack in Australia of an endorsed official valuation service is a serious disability in regard to land valuation and sale. As many as four different official valuations may be placed on one property, each made by a separate public administration, with the result that no one of these valuations carries any authority. The Commonwealth and States should endeavour to arrange for a common land valuation service in each State, since such a single valuation would provide a considerable contribution to the checking of land sales at inflated values.

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Some Varietal Aspects of Australian Apple Production*

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The particular importance of varieties in apple growing is attributable, in the first place, to the relative permanence of trees and the difficulty and expense of changing them to another variety. The variety in annual crops may be changed with comparative ease by the choice of seed, but in the apple industry it could only be changed on a large scale by such expensive and slow methods as reworking established trees to another variety or replacement with young trees. In the second place, the product is perishable to a greater or less extent, and thus the varietal composition of the industry determines the nature of the seasonal supply of fresh fruit and the extent to which the supply is prolonged by cold storage for local and export purposes. For a third reason, varieties retain their identity after harvest, and certain varieties command a substantial premium in the wholesale and retail trades. In spite of the special importance of variety in a crop of permanent structure and perishable product, less information extending over a period of years is available regarding the varietal composition of apple production, than about wheat and some other annual crops.

Attempts have been made by various States to obtain varietal tree censuses,[5, 6] but these have not furnished a complete Australian census. In the 1939/40 season, however, the Australian Apple and Pear Board carried out a Commonwealth-wide census of apple and pear varieties, as bearing and non-bearing trees, which was published in trade journals.[1] Further to this information on number of trees, it may be of interest to present the salient features of a varietal production survey

* Condensation of a survey carried out while the author was seconded part-time to the Commonwealth Department of War Organization of Industry. Helpful criticism of the original survey by various persons, including Mr. W. M. Carne of the Commonwealth Department of Commerce and Agriculture and Mr. C. G. Savage of the N.S.W. Department of Agriculture, is gratefully acknowledged; responsibility for the views expressed in present statement, however, rests with the author.

which the author had the opportunity of preparing from data supplied by the State Departments of Agriculture to the Commonwealth Department of War Organization of Industry. Although the data are not uniform as to season, nor as complete as could be desired, the survey presents broadly the pattern of apple production in the Commonwealth and serves to indicate directions in which improvements in varietal production may be of benefit to the industry as a whole. When this work was begun, no varietal production surveys or data were available, and the results of the present work may, therefore, draw attention to the need for regular surveys of apple production in which varietal aspects are given prominence.

TABLE 1.

Varietal Production of Apples in Australia. (*a*)
(Unit—1,000 bushels.)

Variety.	Qld. (*b*)	N.S.W. (*c*)	Vic. (*d*)	Tas. (*e*)	S.A. (*f*)	W.A. (*g*)	Total.	Percentage of Total.	Order of Varieties in Census. (*m*)
Jonathan	57	159	1,057	895	211	69	2,448	21·4	1
Sturmer	—	—	—	1,546	—	—	1,546	13·5	3
Granny Smith ..	105	320	198	239	33	466	1,361	11·9	2
Cleopatra	—	11	30	654	266	323	1,284	11·2	4
Democrat	—	42	23	532	16	—	618	5·4	5
Scarlet .. .	—	—	—	461	—	—	461	4·0	9
Rome Beauty ..	—	55	231	—	141	—	427	3·7	7
Geeveston	—	—	—	109	—	—	109	0·9	21
French Crab ..	—	—	—	375	—	—	375	3·3	13
Delicious	36	56	68	117	—	10	289	2·5	6
Yates	—	12	141	—	—	75	228	2·0	10
Cox Orange Pippin..	—	—	—	202	—	—	202	1·8	12
Dunns	—	—	39	(*i*)	33	117	189	1·6	8
London Pippin ..	—	57	86	(*i*)	24	—	167	1·4	11
Alfriston	—	—	11	122	—	—	133	1·1	19
Crofton	—	—	—	131	—	—	131	1·1	17
Ballarat	—	—	86	—	—	—	86	0·7	15
Rokewood	—	—	23	—	25	36	84	0·7	16
Gravenstein ..	14	19	44	—	—	—	77	0·7	14
Statesman	—	—	49	—	24	—	73	0·6	18
McIntosh	—	20	—	—	—	—	20	0·2	26
Stone Pippin ..	—	—	—	(*i*)	16	—	16	0·1	28
Dougherty	—	—	—	—	—	13	13	0·1	27
All other varieties (*a*)	26	99	115 (*h*)	662 (*j*)	100	29			
Total	239	930 (*c*)	2,197	6,046 (*n*)	890	1,139 (*k*)	11,440		
Average 1935-1940 (*l*)	251	1,039	2,185	4,845	891	1,225	10,436		

(*a*) Varietal productions of less than 10,000 bushels in any State are included with " all other varieties ".
(*b*) 1941, Acquisition, estimated varietal production, entire crop.
(*c*) 1940, Acquisition, assessed varietal production, exclusive of apples harvested before 1st March equalling approximately 130,000 bushels.
(*d*) Average 1935-40, estimated varietal production.
(*e*) Average 1940-42, assessed varietal production.
(*f*) Average 1935-40, estimated varietal production.
(*g*) 1942 Acquisition, actual varietal production.
(*h*) Includes King Cole and Reinette du Canada, each 10,000 bushels.
(*i*) Production exceeds 10,000 bushels, but details not known.
(*j*) Includes several varieties producing more than 10,000 bushels, see note (*m*) below.
(*k*) Light year for some varieties, e.g. Jonathan, Yates and Rokewood.
(*l*) From Commonwealth Production Bulletins.
(*m*) Census of Apples and Pears.[1] Notable omissions from the list of varietal productions, according to the Census, with their position in the Census, are as follows.—20. Tasman's Pride, 22. Worcester Pearmain, 23. King David, 24. Duke of Clarence, 25. Ribston Pippin. Except King David, these are essentially Tasmanian productions.
(*n*) Tasmanian production was known to exceed official figures by approximately one million bushels.

Principal Varieties.

The production of the main varieties is shown in Table 1. For the Commonwealth, there are differences in the order of importance of varieties on the production basis, compared with the census basis, which as stated earlier, includes non-bearing and bearing trees. It is of interest, therefore, that despite the qualifications to the production data, the first five varieties are almost identical on both bases, and that the first thirteen varieties, representing more than 80 per cent. of production,

are included on both bases. Any reference to a varietal order of importance hereafter is on the basis of the production data of Table 1.

Jonathan, the main variety, accounts for one-fifth of the total production. With three other varieties, Sturmer, Granny Smith and Cleopatra, it accounts for more than half of the production. When the varieties next in order of importance, Democrat, Scarlet, Rome Beauty, French Crab, Delicious and Yates, which together but equal the production of Jonathan, are added to those already named, four-fifths of the total production is embraced. The remaining one-fifth of production is composed of a large number of varieties, the most important of which account for less than 2 per cent. of the total production. Efforts were being made in the pre-war period to reduce the number of minor varieties, and much was being accomplished in this direction by deleting some of them from the export list and by encouraging reworking of the trees to more suitable varieties. Modern methods of multiple stub grafting were proving a great aid in this policy.

Table 1 also shows the distribution of these varieties among the States. Tasmanian Jonathan and Sturmer and Victorian Jonathan dominate Australian varieties and production. The significance of these productions is that each of them exceeds or approximates to the total apple production of any of the other States. Some other significant productions as regards volume or " long lines " are Cleopatra, Democrat, Scarlet, and French Crab in Tasmania, Cleopatra in South Australia and Western Australia, and Granny Smith in Western Australia and New South Wales.

As examples of varietal adaptation, it is of interest that of the ten main varieties no less than three are grown exclusively in Tasmania, while only two, Jonathan and Granny Smith, are grown in all States.

Seasonal Production.

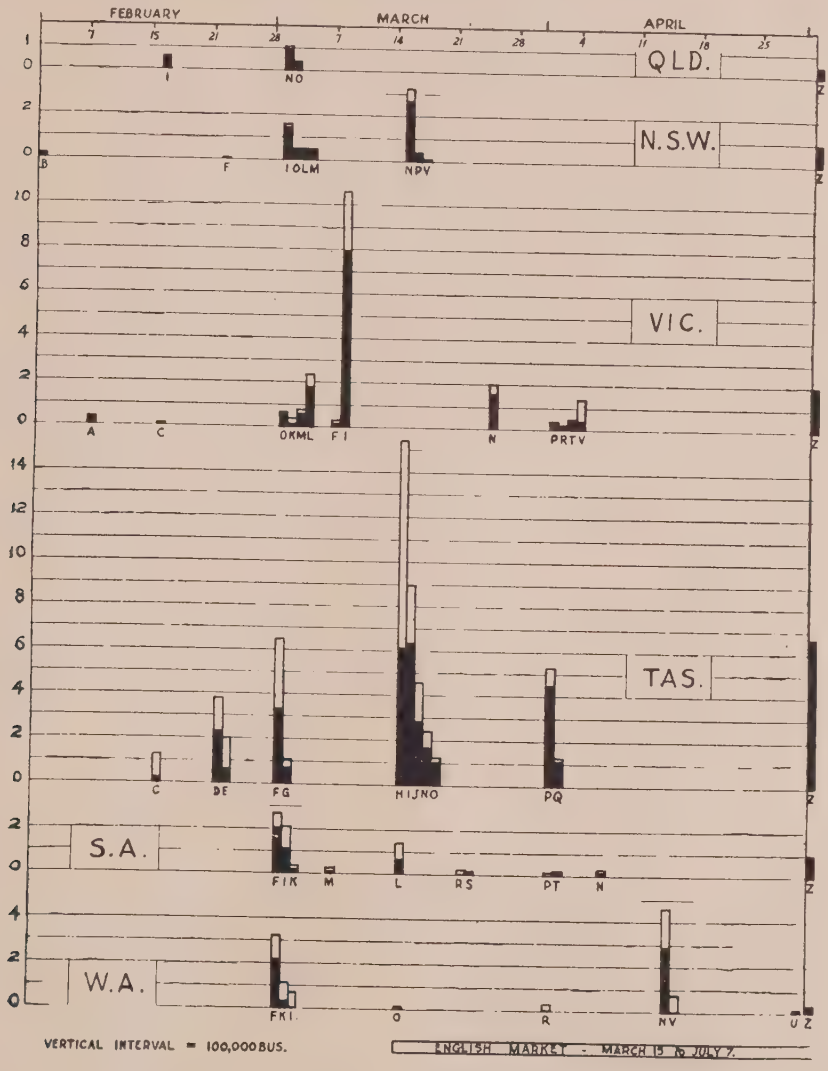
The proportion of early, mid-season and late varieties among the leading varieties is the main factor determining the seasonal characteristics of the apple trade. The many remaining varieties, although collectively important, are quite subordinate from a marketing viewpoint to some main variety at any particular season of ripening.

Besides the proportion of early, midseason and late varieties, the seasonal nature of Commonwealth production is influenced by the climatic earliness or lateness of the producing areas. This factor is shown broadly by the picking dates for varieties recommended by Carne.[2] These picking dates are defined as the earliest picking dates for the variety for local storage (or for export shipment) and the picking period extends for four to six weeks from the stated date. These dates apply to the principal country producing-areas and exclude those generally small areas which are exceptionally early or late in maturity.

In an attempt to indicate the influence of both the varietal and climatic factors on the seasonal nature of production, Figure 1 shows the varietal production, from Table 1, erected on these picking dates, except for Gravenstein and McIntosh, which were assumed by the author. It should be borne in mind that, as already stated, the productions are spread approximately over a six-weeks period from the picking dates shown and that the limitations of the production data, embodied in the footnotes to Table 1, apply.

Figure 1 shows graphically a number of points which have been made earlier, such as the outstanding importance of certain of the main varieties and the collective importance of miscellaneous varieties. It also shows clearly the relative importance of the various States as regards apple production. The main object of the figure, however, is to indicate varietal and climatic influences on seasonal production.

The preponderance of midseason varieties and the comparatively small part played by early and late varieties in the Australian apple production are obvious. It can be seen also that each State has a different distribution of early, midseason and late varietal production. In Queensland and New South Wales production



Key to Varieties.

A. Gravenstein.
B. McIntosh.
C. Alfriston.
D. French Crab.
E. Cox Orange Pippin.
F. Cleopatra.
G. Geeveston.
H. Sturmer.
I. Jonathan.
J. Scarlet.
K. Dunns.
L. Rome Beauty.
M. London Pippin.
N. Granny Smith.
O. Delicious.
P. Democrat.
Q. Crofton.
R. Rokewood.
S. Stone Pippin.
T. Statesman.
U. Dougherty.
V. Yates.
Z. Miscellaneous.

Figure 1.

Varietal production and Export of Apples in Australian States. The height of each vertical bar shows varietal production in bushels, the part of the bar outlined being the amount exported to the United Kingdom. Varieties are placed at their earliest picking dates, those joined having the same picking date as the first of the series. Miscellaneous varieties (Z) are aggregated and their time of harvest or aggregate export is not shown.

increases towards the later ripening varieties ; in Victoria and Tasmania production shows a high midseason peak ; in South Australia production declines from midseason varieties towards late varieties, while in Western Australia production is mainly of midseason and late varieties.

Perhaps the four most noteworthy features are as follows :

(*a*) The distribution of early, midseason and late varietal production in the States appears to contrast with the climatic advantages of the States. On the latter consideration, Queensland is earliest, Tasmania latest, and New South Wales, South and Western Australia more or less equivalent in maturity and earlier than Victoria and Tasmania.

(*b*) Early varieties have been most fully explored in the State (Tasmania) where apple growing has been developed most, these varieties having been adopted especially to supply early export boats. Other States are relatively weak in early varieties.

(*c*) The position with regard to late varieties is less clear-cut than with early varieties because of varietal adaptability. For instance, Granny Smith, regarded as a late variety in New South Wales, is considered as being a late-midseason apple in some other States. The production of late varieties which might be expected in climatically late States is affected apparently by the high production of midseason varieties, whereas in States such as New South Wales and Western Australia, in which midseason varieties do not overshadow other kinds, the later ripening and late varieties have developed appreciably.

(*d*) On account of the climatically early States producing mainly later ripening varieties and the climatically late States producing large quantities of mid-season and early varieties, the great bulk of Australian production occurs in a short period. A calculation spreading each varietal production over a six-week picking period from the picking date shown gives the following approximation to the monthly harvest of the crop :

February (15th-28th)	3 per cent.
March	40 ,, ,,
April	47 ,, ,,
May	7 ,, ,,

Re-distribution of Varieties.

When these characteristics are considered in relation to export and interstate trade requirements they suggest the advisability of encouraging, over a period, a re-distribution of varieties in which more early varieties are grown in early States and more late varieties in the late States. The harvest would then be spread more equally over four months instead of concentrated into two as it appears to be at present. It would supply the dearth of summer apples, and would also effect a number of economies in the trade and storage of apples of benefit both to the local fresh and stored apple trade, and to the export trade. Previous attention has been drawn to the defects in the varietal situation, as Carne[2] discussing the limitation of export of varieties to a recommended period, has stated as follows :

> It is recognized that the existing unbalanced variety plantings in Australia may prevent the necessary limitation of export of each variety to the recommended period. With the increasing data now being collected in relation to the apple industry, it should be possible to stimulate a re-distribution of varieties. The aim should be to secure a variety production which will efficiently cover the season, providing only as much fruit as can be shipped in its best period, plus that required for local or interstate sales. At present too large a proportion of the crop matures in April, and too little in the latter part of February and early March.
>
> Victoria grows too much of two varieties, and in Tasmania too many varieties are extensively planted. Western Australia approaches nearest to the desirable variety distribution.

The fundamental problem with both the early and late apple situation is one of selecting suitable varieties, on account of some defects they possess, and there is room

for improvement in these types of apples by breeding. The main early varieties among which a choice has to be made at present are Alfriston, Gravenstein, McIntosh and Worcester Pearmain, and among late varieties Yates, Crofton, Rokewood, Dougherty, Democrat, and, from some States, Granny Smith.

Export.

The only published data on the varietal nature of apple export are given by Carne[2] for exports to England for the years 1938 and 1939. With the purpose of showing broadly the place of the different varieties in the pre-war export trade and their relation to the export season, these exports are shown for the varieties regarding which there are production data, in Figure 1.

It is apparent that the order of varietal export corresponds fairly closely with the order of varietal production, and thus the seasonal characteristics of the latter, namely heavy midseason varietal production and light early and late production, are extended to the export trade in apple varieties. Monthly export data[4] for the period 1932 to 1936 indicate, in fact, that the shipment of apples from Australia was as follows :

February	..	..	3·8	per cent.	of average	annual export
March	..	..	26·2	,,	,,	,, ,,
April	..	..	38·4	,,	,,	,, ,,
May	..	..	24·2	,,	,,	,, ,,
June	..	..	2·2	,,	,,	,, ,,
July	..	..	0·7	,,	,,	,, ,,

The distribution of varieties in Australian States, shown in Figure 1, is such that only small supplies of apples are available for the United Kingdom market early in the 14-week period (15th March to 7th July) allocated by agreement to Australian apples. The varieties available in February are early varieties from the climatically late States, and there are no early varieties available in quantity from the climatically early States which could be exported earlier than the former class of fruit and thus could arrive at the commencement of the Australian apple season in the United Kingdom. Although such early shipments meet competition from late varieties from U.S.A. held in store and gas-stored English Bramleys, there appears to be room for the development for export of early varieties in the early States.

There is also a sharp drop in the amount of fruit arriving in the United Kingdom towards the end of the 14-week period, that is, fruit which might be shipped in May representing the latest varieties from the late States or States en route to England. The comparatively poor supply of this class of fruit to the United Kingdom market suggests that late varieties could be increased in these States, the increase in the late States being desirable possibly at the expense of midseason varieties.

A third feature worthy of notice in the monthly exports is that during the peak months, March and April, a great number of varieties which have very different inherent qualities arrive on the United Kingdom markets. This results from the coinciding harvest of late varieties in early States and midseason varieties in late States, as may be seen in Figure 1, as well as from the export of minor varieties. In pre-war seasons a good deal was being done by the Apple and Pear Export Council to reduce the number of minor varieties exported. It is evident, however, that a choice of varieties corresponding more closely with the climatic advantages of the different States, would contribute to the solution of this aspect.

Interstate Trade.

In the interstate trade, New South Wales and Queensland import from the other States, except Western Australia, which normally does not participate in the interstate trade. The imports into New South Wales and Queensland have been

estimated[3] as 1,280,000 and 620,000 bushels per annum respectively. The varieties supplied to New South Wales are mainly a group of midseason varieties and a number of late red varieties such as Democrat, Crofton and Yates.

The monthly imports into New South Wales, as recorded by the Apple and Pear Board for 1941 (unpublished data) indicate low imports at the beginning and end of the calendar year, the bulk of the imports being during the winter and spring. The low imports during January and February represent a period preceding the harvest of early varieties in the principal States, but when early varieties can be harvested in New South Wales. It therefore appears that the production of early varieties in New South Wales, already suggested for export purposes, should be increased for local trade also, without risk of incurring interstate trade competition. Part of the trade in summer apples is in early cooking varieties, which may be superseded in the future to a degree which is uncertain at the present time, by processed apples, now being developed extensively in Tasmania. Still, a distinct demand will remain for early dessert varieties, competing with peaches and other stone fruits as dessert fruit, at this time of the year. Further, there was, in pre-war years, an active demand for early apples of high quality, particularly McIntosh, for ships' stores.

The low imports towards the end of the calendar year correspond with the release of locally-grown late-stored apple varieties, mainly Granny Smith and Delicious. It appears that the production of this class of apple should have continued good prospects for the future.

The heavy imports into New South Wales during the winter months of the predominant midseason varieties from southern States are a serious discouragement to producing midseason varieties of medium storage life in New South Wales.

Prospective Production.

Prospective changes in apple production both as to varietal and total amounts of fruit are always of vital interest to growers. In the absence of census information, growers must rely on very general estimates of the situation.

Changes which may be taking place in varietal production can be ascertained by examining the percentage of young non-bearing trees of the different varieties, assuming for this purpose that 10 per cent. of the total number of trees of a variety should be young non-bearing trees, to maintain production. An examination of the data for New South Wales collected by the Apple and Pear Board in the 1939-40 season (unpublished) indicates that the production of early and late varieties will increase, the former more than the latter, while that of midseason varieties will remain about stationary. Nevertheless, these prospects will not make good the apparent deficiency of early apples or alter the State's present characteristic of being a late variety State.

The prospective production of individual varieties is also of interest. In the midseason group, Jonathan, Statesmen and Stayman are the only varieties with any (and slight) prospects of increasing production. Among the late-midseason and late varieties, Delicious and Crofton are outstanding for prospective production, followed by Granny Smith and Dougherty. There is not this strong preference for a restricted number of varieties in the prospective production of early varieties, the majority showing very good prospects of increasing production. Gravenstein and McIntosh will remain the chief varieties by a good margin, but a number of other early varieties have been thought worthy of trial.

Varietal production, especially in the main producing States, has an important influence on apple growing in other States, and it is therefore important to the industry, and to the extension and research work applied to the industry, that varietal production for all States should be surveyed at regular intervals. An important aspect of such surveys should be the position regarding young non-bearing trees.

Conclusions.

The main defects in Commonwealth apple production and export and interstate trade seem to have their origin in an excessive production of midseason varieties and insufficient production of early and late varieties.

These defects appear to be aggravated, generally speaking, by a distribution of these groups of varieties amongst the States which is in apparent contrast with the climatic advantages of the States.

This position suggests the advisability of encouraging a re-distribution of varieties, having as its general aim an increase in early varieties in early States, and of late varieties in late States. This could be carried out in conjunction with the policy of a reduction of varieties, applying to the reworking of bearing trees of unwanted varieties and the planting of new areas.

The present production survey suggests the possible value of periodical surveys of the apple industry in which due prominence is given generally to the varietal aspect and particularly to prospective varietal production, the information for which should be obtained from periodical censuses.

References

1. Australian Apple and Pear Board—Census of Apples and Pears: Fruit Culture and Small Farming, pp. 19-21, October, 1940.
2. Carne, W. M.: Coun. Sci. Ind. Res. (Aust.), pamph. 95, 1940.
3. Dowsett, C. P.: Rural Bank of N.S.W. Unpublished report.
4. Imperial Economic Committee: Apples and Pears. London, 1938.
5. New South Wales Dept. of Agric.: Census of Fruit Trees, 1931.
6. Victoria, Dept. of Agric.: Census of Fruit Trees, 1926.

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Do Legumes Excrete Nitrogenous Compounds?

By

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For many years agriculturalists have observed the advantage of growing mixed crops of legumes and non-legumes, such as clovers with pasture grasses, field peas, vetches and tares with cereals, and cowpeas and soybeans with maize. It has been suggested that during growth, portion of the nitrogen fixed by the legume is excreted into the soil and becomes available to the associated crop. This excreted nitrogen is quite distinct from that resulting from the death and decomposition of the legume.

Virtanen[11] showed that under the climatic conditions of Finland as much as 50 per cent. of the total nitrogen fixed by the legume is excreted from the living nodules and roots primarily as amino acids. Madhok in India[5] claimed that a single chick-pea can supply enough excreted nitrogen for two wheat plants. Workers in England,[6, 8] U.S.S.R.[2] and Germany[7] obtained evidence of excretion in a few cases but none in others; while investigators in Scotland,[1] Germany,[3] U.S.A.[12] and South Australia[9] secured entirely negative results and concluded that only decaying legumes could provide nitrogen for a non-leguminous crop.

The apparent discrepancies in these results may be explained by differences in climate in the various countries. If the legume tops do not synthesize sufficient carbohydrate to combine with the nitrogenous compounds fixed in the nodules to form plant proteins, the surplus nitrogen is excreted. Those climatic factors that interfere with photosynthesis, such as excessively high or low temperature, cloudiness and shading from light, and high humidity all promote excretion of nitrogen which

may benefit interplanted non-legumes. Other factors which influence the quantity of nitrogen fixed and the proportion excreted, include the species and variety of legume and the strain of Rhizobia growing in symbiosis.[12]

This problem has received little attention in New South Wales and therefore the following investigation was undertaken in Sydney.

Experimental Work.

Excretion of Nitrogen into Sand.

In an attempt to detect excretion of nitrogenous substances into sand, nine different legumes of the Pea group were inoculated with each of fifteen strains of the root nodule bacterium, *Rhizobium leguminosarum*, and grown during the autumn and winter of 1941. Uninoculated controls were prepared for each of the legumes. Four hundred and thirty-two glass jars each containing two kilograms of sterile washed sand were each sown with four sterilized seeds of a legume and watered with dilute Hoagland and Arnon's[4] nitrogen-free mineral solution. Each treatment was done in triplicate. Three weeks after germination, when nodulation was established, the jars were moved outside into the open. At the flowering stage the legumes and sand were separately oven dried, weighed and analysed for nitrogen by the Kjeldahl method.

It was found that the effectiveness of the Rhizobial strains differed, some strains fixed large amounts of nitrogen while others fixed scarcely any. The quantity of nitrogen found in the sand samples varied slightly, depending on the different amount of root material remaining ; but in no case was there evidence that nitrogen had accumulated as a result of excretion by nodulated legumes.

Excretion of Nitrogen to an Associated Crop.

It was thought that the first experiment may have failed to detect excretion because the sand acted as a poor absorbing agent.[10] A second experiment was carried out in which various non-legumes, serving as nitrogen absorbers, were grown in association with different legumes. The combinations included some often used in agriculture, such as the usual pasture mixtures of grasses and clovers, also oats with lucerne, field pea and golden tares, while other associations were of academic rather than practical interest.

Duplicate porous pots each containing five kilograms of washed sand were planted with six legumes in association with six non-legumes, and controls for both plant types were provided. The legumes were inoculated with suitable, efficient strains of Rhizobia to ensure nodulation. The plants were watered with a nitrogen-free mineral solution as before, and leaching of excreted nitrogenous substances was prevented by collecting the drainage in impervious saucers in which the pots stood. The plants were grown in the open for five months during the winter, spring and early summer of 1941. In the mixture, New Zealand blue lupin and perennial rye grass, the legume formed pods very early and the plants, together with perennial rye from a control pot, were harvested after four months' growth. At the conclusion of the experiment the legumes, non-legumes and sand were separately oven-dried, weighed and analysed for nitrogen. The state of maturity, yield and percentage of nitrogen of the crop, and the total amount of nitrogen in the plants and the sand are given in Table 1, while the appearance of certain of the plants at harvest are shown in Figures 1 to 4.

It is evident from Table 1 that the yield and amount of nitrogen for the associated legume and non-legume respectively were frequently less than when the plants were grown alone. This is in agreement with data obtained in South Australia,[9] where, however, the plants competed for a limited supply of minerals. In this experiment the adverse results cannot be explained by competition for minerals and water because, with the exception of nitrogen, more than sufficient were provided. The influence of shading and root interference may account for the depression noticed with the mixed crops. There was no evidence of appreciable nitrogen excretion to

TABLE 1.

Dry Weight and Nitrogen Content of Legumes and Associated Non-legumes and Control Plants.

Treatment.	State of Maturity.	Yields. (Average of Six Plants.)			Total Amount Nitrogen in Sand. Milligrammes.
		Dry Weight. Grammes.	Nitrogen Percent.	Total Nitrogen. Milligrammes.	
Legume+Non-legume					
White clover	Flowering.	106·82	2·064	2201	27·5
Perennial rye	Vegetative.	2·26	0·896	20·2	
White clover	Flowering.	94·23	2·358	2223	42·5
Phalaris tuberosa	Vegetative.	1·54	0·779	12·0	
Red clover	Budding.	131·17	1·749	2294	38·5
Italian rye	Flowering.	31·65	0·622	197·0	
Subterranean clover	Seeding.	108·63	1·503	1631	56·0
Perennial rye	Vegetative.	4·18	0·909	38·1	
Subterranean clover	Seeding.	149·01	0·921	1372	34·5
Phalaris tuberosa	Vegetative.	1·59	0·647	10·3	
Lucerne	Flowering.	29·25	1·829	534·8	68·5
Phalaris tuberosa	Vegetative.	5·34	0·518	27·6	
Lucerne	Flowering.	41·48	1·358	563·3	35·0
Wimmera rye	Flowering.	12·75	0·301	38·4	
Lucerne	Flowering.	31·76	1·825	579·7	37·0
Oats	Seeding.	11·44	0·496	56·7	
Burr trefoil	Seeding.	29·96	2·071	621·0	30·0
Phalaris tuberosa	Vegetative.	1·85	0·750	13·9	
Field pea	Early Podding.	61·82	1·695	1049	66·5
Oats	Seeding.	10·45	0·541	56·5	
Golden tare	Early Podding.	90·11	1·626	1465	87·5
Oats	Seeding.	4·59	0·539	24·8	
Tick bean	Early Podding.	45·69	1·567	714·2	45·0
Oats	Seeding.	12·25	0·442	54·2	
Garden pea	Podding.	58·65	1·324	777·1	83·0
Tomato	Vegetative.	0·45	1·273	5·7	
N.Z. Blue lupin	Podding.	42·85	2·010	862·5	105·0
Perennial rye	Vegetative.	10·62	0·746	79·3	
Bean	Early Podding.	12·74	2·265	288·4	66·5
Tomato	Vegetative.	1·14	1·360	15·5	
Legume alone.					
White clover	Flowering.	136·32	2·270	3093·0	60·0
Red clover	Budding.	114·06	1·786	2039·6	76·0
Subterranean clover	Seeding.	147·10	1·620	2384·0	115·0
Lucerne	Flowering.	55·60	1·500	834·4	80·0
Burr trefoil	Seeding.	29·55	2·049	606·2	45·5
Field pea	Podding.	69·30	1·642	1138·0	115·5
Golden tare	Early Podding.	101·01	1·968	1988·0	81·0
Tick bean	Early Podding.	63·15	1·671	1044·7	31·5
Garden pea	Podding.	60·00	1·412	847·4	56·0
N.Z. lupin	Podding.	68·10	1·781	1212·8	120·0
Bean	Early Podding.	28·30	1·981	560·0	75·0
Non-legume alone.					
Perennial rye	Vegetative.	7·19	0·591	46·6	38·0
Perennial rye (control pot for N.Z. Blue lupin+Perennial rye)	Vegetative.	6·03	0·702	42·3	57·5
Phalaris tuberosa	Vegetative.	7·88	0·621	49·0	27·0
Italian rye	Flowering.	9·04	0·570	51·5	45·0
Wimmera rye	Flowering.	6·60	0·597	36·2	28·0
Oats	Seeding.	20·20	0·334	67·5	42·0
Tomato	Vegetative.	1·08	1·215	13·2	41·5
Sand.					
(Start)	—	—	—	—	24·0
(End)	—	—	—	—	32·5

the associated crop except in three mixtures, namely red clover and Italian rye, lucerne and Wimmera rye, and N.Z. blue lupin and perennial rye ; and even here the associated non-legumes suffered from nitrogen starvation. The amounts of nitrogen remaining in the sand show considerable variation. This was due in part to the different quantities of root material remaining after removal of the plants. In the cases of N.Z. blue lupin with perennial rye, N.Z. blue lupin, field pea and subterranean clover the high figures were due to partial breakdown of the nodules which occurred towards harvest time.

Figure 1.

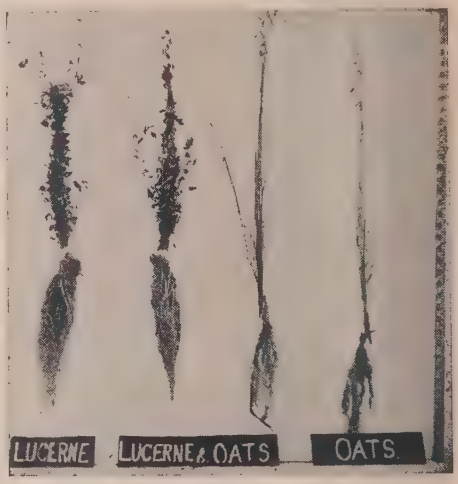

Figure 2.

Figure 3.

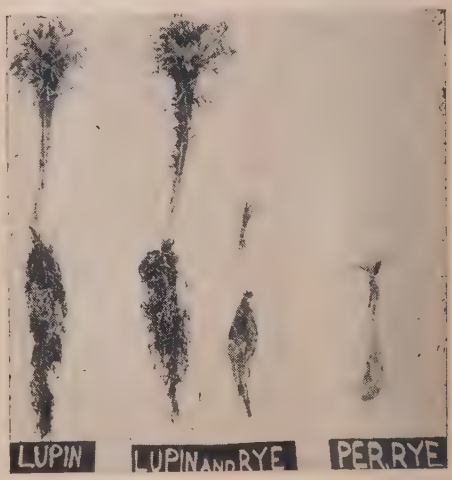

Figure 4.

Legumes and non-legumes grown separately and in association.

Influence of Humidity on Nitrogen Excretion.

Several observers have noticed that in certain districts of the North Coast of New South Wales the growth of pasture grasses seems to be improved by the presence of legumes. It was thought that the high humidity of this area may promote excretion of nitrogen from the legume to the non-legume and an experiment was designed to test the theory.

Two sets of mason jars each containing two kilograms of washed sand were planted with three legumes in association with three non-legumes, and controls for both plant types were included. The mixtures used were white clover and perennial rye, and golden tares and oats. Triplicate jars were prepared for each treatment. The legumes were inoculated with effective strains of Rhizobia. The two sets of jars were placed inside glass chambers, one set being kept at a low humidity and the other set maintained at a high humidity by vapour from a large tray of water. The plants were grown for a period of three months during which they were watered with a nitrogen-free mineral solution. At harvest the legumes, non-legumes and sand were separately oven-dried, weighed and analysed for nitrogen. The results are set out in Table 2 and they indicate that the yields and the amounts of nitrogen fixed by the legumes were less under humid conditions than under dry conditions. This depression was not so marked in the case of the grasses which exhibited extreme nitrogen starvation under both conditions. There was no evidence of nitrogen excretion either in a humid or a dry atmosphere.

TABLE 2.

Influence of Humidity on Yield and Nitrogen Content of Legumes and Non-legumes and Control Plants.

Treatment.	State of Maturity.	Yields (Average of Six Plants).			Total Amount of Nitrogen in Sand. Milligrammes.
		Dry Weight. Grammes.	Nitrogen. Percent.	Total Nitrogen. Milligrammes.	
White clover	Humid.	0·723	2·176	15·7	9·8
Perennial rye	Humid.	0·585	0·597	3·5	
White clover	Humid.	0·746	2·194	16·4	10·1
Perennial rye	Humid.	0·607	0·573	3·5	9·6
White clover	Dry.	0·815	2·291	18·7	10·9
Perennial rye	Dry.	0·575	0·632	3·6	
White clover	Dry.	0·834	2·278	18·9	10·8
Perennial rye	Dry.	0·591	0·572	3·4	9·7
Golden tare	Humid.	1·310	1·711	22·4	10·5
Oats	Humid.	1·645	0·473	7·8	
Golden tare	Humid.	1·278	1·816	23·2	11·2
Oats	Humid.	1·671	0·502	8·4	10·1
Golden tare	Dry.	2·920	2·020	58·5	12·4
Oats	Dry.	1·598	0·564	9·0	
Golden tare	Dry.	3·046	2·127	64·8	11·9
Oats	Dry.	1·832	0·542	9·9	9·8

Conclusions.

The experiments suggest that healthy, well-nodulated legumes growing under the climatic conditions of Sydney do not excrete sufficient nitrogen to benefit non-legumes growing in association. A humid atmosphere fails to promote nitrogen

excretion from white clover and golden tares. The growth of legumes and non-legumes is depressed by interplanting. These findings in no way deny that non-legumes are benefited by the release of nitrogen and minerals during the decomposition of leguminous plants.

References.

1. Bond, G., and Boyes, J.: Ann. Bot. (n.s.), 3: 901-914, 1939.
2. Demidenko, T. T., and Timofeeva, E. F.: Compt. Rend. Acad. Sci. (U.S.S.R.), 14: 231-233, 1937.
3. Engl, H., and Roberg, M.: Ber. Deut. Bot. Gesell., 56: 337-352, 1938.
4. Hoagland, D. R., and Arnon, D. I.: Calif. Agr. Exp. Sta., Cir. 347: 1-39, 1938.
5. Madhok, M. R.: Soil Sci., 49: 419-432, 1940.
6. Nowotnowna, A.: J. Agr. Sci., 27: 503-510, 1937.
7. Scholz, W.. Bodenk. u. Pflanzenernähr., 15: 47-73, 1939.
8. Thornton, H. G., and Nicol, H.: J. Agr. Sci., 24: 269-282, and 540-543, 1934.
9. Trumble, H. C., Strong, T. H., and Shapter, R. E.: Coun. Sci. Ind. Res. (Aust.), Bul. 105, 1937.
10. Virtanen, A. I.: Nature, 140: 683, 1937.
11. ————————: Cattle Fodder and Human Nutrition. Cambridge University Press, London. 108 pp., 1938.
12. Wilson, P. W.: The Biochemistry of Symbiotic Nitrogen Fixation. University of Wisconsin Press, Madison. 302 pp., 1940.

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Breeding for Bunt Resistance in Australian Wheats

By

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The pioneer work of William Farrer in systematically breeding wheat varieties for resistance to bunt is well known to cereal breeders. His two wheats, Florence and Genoa, are resistant to many races of *Tilletia levis* and *T. tritici*, and they have been used as parents in breeding work in Australia and the United States of America. For example, the bunt resistant wheats Dindiloa, S.H.J. and Ridit are each derived from Florence.

The demonstration by Darnell-Smith in 1915 of the value of copper carbonate as a dry pickle in preventing bunt is also well known. This method of control is usually so effective that the task of producing bunt resistant wheats for Australian conditions has not been considered to be as urgent as that of developing wheats resistant to flag smut and stem rust. However, where the inoculum is soil borne, seed treatment is generally regarded as not being wholly effective, and in this connection it is of interest to report one case at the Waite Institute in 1940, where a heavy infection of wheat was traced definitely to soil borne inoculum. Under Australian conditions this may perhaps be exceptional, and the infection that occurs is usually regarded as being due to inefficient seed treatment. Even if treatments were always efficient in controlling bunt, they entail trouble and expense so that the final solution to the problem must be found in the incorporation of satisfactory " resistant " genes in our standard varieties.

In 1939 studies were commenced at the Waite Institute having as their object the determination of the relative resistance of the newer Australian wheat varieties

in comparison with older varieties and others from America. A large collection of rust-resistant crossbreds derived from the American variety Hope were also tested. This variety is known to be resistant to many races of *T. levis* and *T. tritici* and it was expected that some of its derivatives would also be resistant. In addition to this survey a search was made for varieties having " resistant " genes which could readily be incorporated in standard Australian varieties by the back-cross method of breeding. In connection with this work it was considered essential to determine the physiological races of *T. levis* and *T. tritici* present in Australia, and also to understand something of the way in which the selected " resistant " genes are inherited.

An excellent review of Australian and overseas work on all aspects of bunt has recently been published[6] and this forms a background for the studies herein reported.

Methods of Testing for Resistance.

Duplicate samples of seed dusted with an excess of spores were sown late in the season (July) in unmanured rows 12 ft. long, spaced 14 inches apart. In this way it was hoped to provide optimum conditions for infection. Where separate collections of bunt inoculum were used, full precautions were taken to guard against cross infection and no definite case of contamination was encountered. Unless otherwise stated all collections of bunt had their origin in single head acquisitions. In recording the percentage of infection in the rows, a plant was classed as susceptible if bunt balls could be found on any one of the ears.

Varietal Resistance.

A number of varieties has been tested each year, using a mixed inoculum composed of a number of races of *T. levis* and *T. tritici*. It should be emphasized that this collection of races is not necessarily representative of those present in the wheat areas of Australia. The results have been consistent from year to year, so that it is sufficient to quote the figures for 1941 and 1942 when heavy and light infections respectively were obtained. The mean percentages of bunted plants per row are set out in Table 1.

From the figures for the Australian varieties it is evident that there has been no improvement in resistance over that originally secured by Farrer in Florence. All the Hope crossbreds tested were quite susceptible. Extensive trials with Warigo (Nabawa × Hope) have proved it to be slightly more resistant than Nabawa but more susceptible than Hope.

Many of the American wheats listed in Table 1 were resistant and several of these have been used by Australian breeders, but as yet their " resistant " genes have not been incorporated in commercial varieties. Wheats like Albit, Martin and White Federation 38 are known to be highly resistant to certain races of *T. levis* and *T. tritici* and the fact that they were susceptible in these tests indicates the presence in Australia of races capable of attacking them. With these varieties, the infection figure of 20-30 per cent. was easily raised to 70-80 per cent. by reinoculating them with inoculum from infected plants of the same variety, and in fact, certain races described herein originated in this way. On the other hand similar attempts to increase the infection rating for wheats like Hope, Rio, Oro and Florence have failed, indicating the absence of races capable of attacking these wheats severely.

With the exception of Doubbi, the tetraploid wheats were quite susceptible. In trials at the Waite Institute Doubbi has always been immune to bunt, flag smut and loose smut, and it is therefore being used in crosses with the *vulgare* wheats.

Rye has been immune in all tests and it is interesting to note the contrast in the reactions of the two wheat-rye hybrids. One was immune while the other was fully susceptible.

TABLE 1.

Reactions of Australian and American Varieties to a Mixed Collection of Races of T. levis *and* T. tritici.

Australian Varieties.			American Varieties.			Tetraploid Varieties.			Wheat-Rye Hybrids.		
Variety.	Mean Percentage Infected Plants per Row.		Variety.	Mean Percentage Infected Plants per Row.		Variety.	Mean Percentage Infected Plants per Row.		Variety.	Mean Percentage Infected Plants per Row.	
	1941	1942		1941	1942		1941	1942		1941	1942
Bencubbin ..	45	23	Albit ..	35	22	Doubbi ..	0	0	Secalotricum		
Bobin ..	65	—	Apex ..	—	6	E.16.. ..	58	—	(200) ..	80	—
Bordan ..	80	—	Baart 38			Gaza ..	84	63	Secalotricum		
Carrabin ..	63	—	C.I.11907	62	56	Huguenot ..	60	—	(144) ..	0	—
Cedar ..	29	15	Canus ..	54	17	Mindum ..	28	24			
Currawa ..	71	—	Coronation	—	13	*T. persicum*	30	—			
Dan ..	42	—	Forward ..	58	—	Purple Kernel	80	—			
Daphne ..	59	—	Frondosa								
Dindiloa ..	16	3	C.I.12078	—	39						
Dundee ..	62	40	Frontiera								
Eureka II	43	33	C.I.12019	—	33						
Federation ..	71	48	Fulcaster ..	74	—						
Fedweb ..	61	—	Garnet ..	38	11						
Florence (1066) ..	26	8	Hope ..	8	0						
Ford ..	78	50	Hussar C.I.4843	1	0						
Free Gallipoli	52	—	Hussar-Hohenheimer								
Genoa ..	33	6	C.I.10068-1	—	0						
Geeralying ..	59	—	Hybrid 128	79	62						
Ghurka ..	45	32	Marquillo ..	41	—						
Ghurka (Tuela Seln.) ..	32	—	Marquis ..	56	20						
Gluclub ..	76	—	Martin								
Gluwari ..	77	—	C.I.4463	27	46						
Gluyas (early)	71	—	Nebred								
Gluyas (late)	68	—	C.I.10094	0	2						
Gular ..	89	—	Oro C.I.8220	0	0						
Hard Federation ..	83	—	Oro-Turkey-Florence								
Hofed ..	41	—	C.I.11865	0	0						
King's White	85	—	Preston ..	59	—						
Koala ..	60	—	Red Bobs ..	—	44						
Magnet ..	61	—	Regent ..	—	2						
Merridin ..	79	—	Relief-Ridit								
Minister ..	61	—	C.I.11908	0	2						
Nabawa ..	61	52	Renown ..	—	0						
Noongar ..	68	—	Rio ..	2	0						
Pindar ..	51	25	Ridit C.I.6703	0	0						
Pusa 4 ..	78	—	Selection 1403	27	7						
Quadrat ..	26	19	Sonora ..	92	—						
Rajah ..	76	—	Supreza ..	—	37						
Ranee 4H ..	67	48	Turkey 3055	0	0						
Rapier ..	93	31	Turkey 10016	0	2						
Seewari ..	83	—	Turkey 10015	11	7						
Sepoy 324J..	64	—	Turkey 38-453	14	5						
S.H.J. ..	31	7	Turkey 41-378	76	55						
Sturt ..	64	—	White Federation 38								
Sword ..	79	—	C.I.11906	22	37						
Thew ..	73	—									
Totadgin ..	64	—									
Warigo ..	44	15									
Waria ..	83	—									

Physiological Races of T. levis and T. tritici.

Records of the relative distribution in Australia of the two species *T. levis* and *T. tritici* have been made from time to time. McAlpine[8] in Victoria in 1909 and Carne[3] in Western Australia in 1925 both found *T. levis* to be more common than *T. tritici*. Churchward[4] in 1932 found both species widely distributed throughout Australia, and at that time *T. tritici* was more common than *T. levis* in South Australia.

During the past three years all of the twelve collections from South Australia have been *T. levis*. One collection from Victoria was *T. levis*, while both species have been collected from New South Wales and Western Australia.

In regard to race specialization within these two species, it is most desirable that the relationships between Australian races and those occurring in other countries should be ascertained. The need for a standard technique for physiologic race determinations has been stressed by Churchward,[5] Rodenhiser and Holton[9] and others.

Using four spring wheats, Kota, Progress, Preston and Red Bobs, Churchward[5] grouped Australian collections of bunt in three races of *T. tritici* and four of *T. levis*. He was able to relate four of these to others determined elsewhere. The varieties he used frequently varied in their reactions in different years, and they were insufficient to differentiate between certain overseas races.

Rodenhiser and Holton[7, 9] used a different set of winter and spring differential wheats and it is their set of varieties that has been used in this work in South Australia. While they have been satisfactory, some difficulty was met with the winter wheats, which, because of their lateness, frequently suffer from the dry conditions which prevail during November and December. However, the use of their differentials has enabled a comparison to be made between Australian races and those studied in the United States. One point of difference in the methods used in these studies is that it was found preferable to base infection percentages on the number of diseased plants per row rather than on a count of the number of diseased heads. For practical plant breeding purposes it may be necessary to utilize other differentials better suited to local conditions, and five additional spring wheats have therefore been included. Dr. Holton has kindly made available the reactions of two of these, Florence and White Federation 38. The others used are Rapier, a standard susceptible variety, Orfed from the cross Oro × Federation, and Selection 1403, a wheat possessing Briggs' H factor for resistance to race T.1.

South Australian collections of *T. levis* were made in 1942 and 1943 and the infection results with these are set out in Table 2. The first preliminary tests were made with inoculum from several plants from a single crop, and later tests were conducted with inoculum derived from single head collections.

TABLE 2.

Percentage of Bunt Produced in Differential Varieties of Wheat by Nine Collections of Tilletia levis *from South Australian Crops.*

Collection Number and Origin.	Year of Test.	Percentage Smutted Plants in																		Race Designation.
		Hybrid 128.	Ridit.	Oro.	Hohenheimer.	Hussar.	Albit.	Martin.	White Odessa.	Ulka.	Marquis.	Canus.	Mindum.	Rapier.	Orfed.	Florence.	Selection 1403.	White Federation 38.		
1. Curramulka, 1942	1943	—	—	0	—	—	—	—	—	—	—	0	—	30	—	—	0	0		
	1944	78	0	0	0	0	0	0	0	91	9	0	—	82	1	2	2	0		L.1
2. Mallala, 1942	1943	—	—	0	—	—	—	—	—	—	—	0	—	56	—	—	0	0		L.1
3. Paskeville, 1942	1943	—	—	0	—	0	—	—	—	—	4	0	—	30	—	—	0	0		
	1944	70	0	3	0	0	0	0	0	94	9	3	—	70	0	0	2	0		L.1
4. Neale's Flat, 1942	1944	65	0	0	0	0	0	0	0	77	9	0	—	82	0	0	0	0		L.1
5. Salter's Springs, 1942	1943	—	0	—	—	4	0	0	0	—	9	0	21	44	—	—	0	0		
	1944	85	0	0	0	0	0	0	0	86	4	3	—	66	3	0	2	0		L.1
6. Weetulta, 1942	1943	—	0	0	—	0	0	—	0	—	3	0	16	47	—	0	0	5		L.1
7. Ardrossan, 1942	1943	—	0	0	0	0	0	8	—	71	16	3	16	42	—	2	0	0		
	1944	54	0	0	0	0	0	0	0	90	24	0	—	78	0	7	0	0		L.1
16. Salter's Springs, 1943	1944	62	0	0	0	0	0	0	0	82	15	0	—	63	3	0	0	0		L.1
17. Urania, 1943	1944	67	0	0	0	0	0	0	1	100	20	0	—	95	0	4	0	2		L.1

From Table 2 it is evident that all nine collections gave similar reactions, viz. Hybrid 128, Ulka and Rapier, susceptible ; Marquis and Mindum, intermediate ;

and the remainder resistant. They all thus correspond to Rodenhiser and Holton's race L.1.

Similar reactions to the above were recorded for a bulk collection of *T. levis* from Temora, New South Wales (see Table 3).

Three other collections of *T. levis* were examined and the results are recorded in Table 3. One was derived from a single plant of Selection 1403, another from a single plant of Martin, while the third was a bulk collection supplied by Dr. I. A. Watson of Sydney University, N.S.W. It is not known to what extent these three collections are representative of the races present in the wheat areas of Australia.

TABLE 3.

Percentage of Bunt Produced on Differential Varieties of Wheat by Four Miscellaneous Collections of T. levis.

Collection Number and Origin.	Year of Test.	Percentage Smutted Plants in																		Race Designation.
		Hybrid 128.	Ridit.	Oro.	Hohenheimer.	Hussar.	Albit.	Martin.	White Odessa.	Ulka.	Marquis.	Canus.	Mindum.	Rapier.	Orfed.	Florence.	Selection 1403.	White Federation 38.		
11. Selection 1403, 1941	1942	59	—	4	—	0	0	—	—	—	—	45	—	—	—	—	45	4		Similar to L.3.
	1943	—	0	0	—	0	0	0	—	—	42	43	24	58	—	0	46	0		
	1944	84	0	5	0	0	0	2	13	96	59	76	—	88	13	8	78	22		
9. Martin, 1941	1942	37	—	—	—	0	6	40	—	—	—	0	—	—	—	—	—	—		Similar to L.4.
	1943	—	0	0	—	0	47	39	—	—	45	0	—	50	—	6	0	10		
	1944	89	4	0	0	0	20	21	64	94	51	0	—	83	2	13	0	92		
14. Sydney, N.S.W. (bulk), 1943 ..	1944	88	3	0	0	0	44	27	70	91	41	0	—	76	2	17	2	67		Similar to L.4.
15. Temora, N.S.W. (bulk), 1943 ..	1944	57	0	0	0	0	0	0	0	86	4	2	—	72	0	0	2	2		Similar to L.1.

Collection 11 is similar to Rodenhiser and Holton's race L.3. Collections 9 and 14 are similar to each other. They resemble race L.4 except that Marquis is susceptible rather than intermediate in its reaction. White Odessa seems to be more susceptible than Martin and Albit to these two collections.

Three collections of *T. tritici* were examined. Two were from single heads of Ranee and White Federation 38 respectively, and, like collections 9 and 11, nothing is known of their distribution in Australian wheat crops. Collection 18 was a bulk collection from Western Australian Department of Agriculture. The results obtained with these three collections are recorded in Table 4.

Collection 8 resembles Rodenhiser and Holton's race T.5 or T.7, but further tests are necessary to establish its identity. Collection 13 is similar to T.2 except for the intermediate reaction of Mindum. Preliminary tests indicate a similarity between collection 18 and collection 13.

Similarities between certain races of *T. levis* and others of *T. tritici* can be seen in the results of several workers, and it is of interest to note that collection 13 of *T. tritici* has similar pathogenic habits to those collections from South Australia and Temora.

A Breeding Programme.

Briggs[1] has shown how readily bunt resistance can be incorporated in commercial varieties of wheat in California. He has shown, firstly, that the resistance of Martin to race T.1 is due to a single dominant gene (M) and secondly, that this gene M can be transferred very conveniently to other wheats by the back-cross method of breeding. This method of breeding has been used largely in the disease

TABLE 4.

Percentage of Bunt Produced on Differential Varieties of Wheat by Three Miscellaneous Collections of T. tritici.

Collection Number and Origin.	Year of Test.	Percentage Smutted Plants in																		Race Designation.
		Hybrid 128.	Ridit.	Oro.	Hohenheimer.	Hussar.	Albit.	Martin.	White Odessa.	Ulka.	Marquis.	Canus.	Mindum.	Rapier.	Orfed.	Florence.	Selection 1403.	White Federation 38.		
8. White Federation 38, 1941 ..	1942	73	—	—	—	2	10	13	—	—	—	46	—	—	—	—	—	'67		Resembles T.5 or T.7.
	1943	—	2	7	—	8	41	33	—	78	20	38	18	54	—	12	27	64		
	1944	72	0	0	0	5	20	14	75	80	58	61	—	65	7	20	70	73		
13. Ranee, 1940	1941	—	0	0	—	0	0	0	—	—	23	—	23	—	—	32	0	—		
	1942	70	0	0	—	0	0	0	—	63	0	0	6	—	—	12	0	0		
	1943	—	0	0	0	0	0	0	0	83	0	0	24	64	—	—	0	0		Similar to T.2.
	1944	84	0	0	0	0	0	0	0	100	4	0	—	76	2	7	0	2		
18. West. Aust. (bulk), 1943 ..	1944	—	—	—	—	—	—	0	—	93	13	0	—	77	0	—	0	0		——

resistance work at the Waite Institute, and in 1942 crosses were made in an attempt to incorporate bunt resistance in several standard Australian varieties of wheat. Many of the American varieties available for this work are red-grained winter types, making it almost essential to adopt this method ; but in any case Australian wheats are so well adapted to local conditions that in back-crossing it is possible to retain those characters of yield, drought resistance, etc., which have been secured during the past forty or fifty years.

Before embarking on this programme of work, a choice had to be made as to what " resistant " genes were to be used. The choice proved rather difficult because a full knowledge of the number and distribution of races of *T. levis* and *T. tritici* in Australia is not yet available, nor is there sufficient knowledge of the relationships existing between the " resistant " genes and the various races of *T. levis* and *T. tritici*. Briggs[2] has shown that the resistance to race T.1 of Martin, Selection 1403 and Oro is due in each case to single but different genes named M, H and T respectively. Each of these varieties is susceptible to known races of bunt, so it is evident that the genes M, H and T do not confer a general resistance. Furthermore, the combination of two genes H and M which occurs in Hussar does not confer a resistance against all known races. Whether the combination H, M and T would provide this necessary general resistance is not known. However, it is not very difficult, by back-crossing, to build up varieties containing all these genes, and unless a new " race-independent " gene can be found it seems that several genes must be used in combination in order to secure complete resistance.

The problem of breeding bunt resistant wheats is plainly an involved one and must be approached with caution until knowledge of gene-race relationships is extended.

Because Oro is known to be susceptible to only one race L.8, and because it has always proved highly resistant to those Australian races so far tested, it has been selected as the main parent in our breeding programme. In addition to the knowledge available on the inheritance of its resistance to race T.1[2] and race T.11[10] preliminary tests have shown it to possess a major gene for resistance to our local race L.1.

At the present time the following F.3 lines which are homozygous resistant to race L.1 have been secured: (Bencubbin × Oro)′ × Bencubbin, (Ranee × Oro)′ × Ranee, and (Rapier × Oro)′ × Rapier.

White Federation 38 and Selection 1403 are white-grained spring wheats resistant to our local race L.1, but because they are known to be susceptible to

certain Australian races their use has been restricted. However, the following F.3 lines which are homozygous resistant to race L.1 have been secured: (Bencubbin × Selection 1403)′ × Bencubbin, (Ranee × Selection 1403)′ × Ranee, and (Ranee × White Federation 38)′ × Ranee.

Mention has already been made of the high bunt resistance which the tetraploid wheat Doubbi possesses. Preliminary tests have shown it to possess a major gene for resistance and steps have been taken to incorporate this resistance in our commercial varieties. *Vulgare*-like resistant lines have been secured from the cross (Ranee × Doubbi)′ × Ranee. These lines are being used as parents in further backcrosses to Ranee and other varieties.

Summary.

Trials have been conducted with a number of Australian and American wheats and the results have shown that while no Australian varieties are superior in resistance to Florence, many American varieties are resistant to the races contained in the mixed inoculum used in the tests.

An analysis has been made of several Australian collections of *T. levis* and *T. tritici* in an attempt to relate them to the races of Rodenhiser and Holton.

A back-cross breeding programme aimed at incorporating bunt resistance into commercial Australian wheats is outlined and the progress made has been indicated.

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References.

1. Briggs, F. N.: J. Am. Soc. Agron., 22: 239-244, 1930.
2. ————————: Genetics, 19: 73-82, 1934.
3. Carne, W. M.: J. Dept. Agric. West. Aust., 2: 10-19, 1925.
4. Churchward, J. G.: Proc. Linn. Soc. N.S.W., 57: 403-408, 1932.
5. ————————: J. and Proc. Roy. Soc. N.S.W., 71: 362-384, 1938.
6. Holton, C. S., and Heald, F. D.: Bunt or Stinking Smut of Wheat, Burgess Publishing Co., Minnesota, 1941.
7. ———————— and Rodenhiser, H. A.: Phytopath, 32: 117-129, 1942.
8. McAlpine, D.: J. Dept. Agric. Vic., 7: 255-260, 1909.
9. Rodenhiser, H. A., and Holton, C. S.: J. Agric. Res., 55: 483-496, 1937.
10. Vogel, O. A., Classen, C. E., and Gaines, E. F.: J. Am. Soc. Agron., 36: 473-479, 1944.

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The Species *Pisum sativum* in Relation to Australian Agriculture

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The decline in soil fertility which has taken place in many wheat areas in southern Australia has been noted by several workers[9] in recent years. In some districts this tendency can be counteracted by the adoption of systems of "ley farming". In this, long rotations are used which involve the introduction of pastures in which leguminous species (subterranean clover and medicks) are usually prominent. In some districts, however, ley farming may not be satisfactory and neither clovers nor medicks are readily introduced into the system. Under such circumstances an alternative crop, especially if leguminous in character, is highly desirable. *Pisum sativum* is possibly the most promising annual species to investigate for this purpose. The first results from the rotation trials at the Waite Institute[10] show it to be the outstanding forage crop for use in a fallow-wheat-forage crop-pasture rotation in that climate.

Systematic Classification.

For centuries *P. sativum* and allied species have supplied much of the protein essential for life in the cool temperate regions of Eurasia. Deliberate attempts to select pea varieties particularly suited to special districts and uses have been comparatively recent, although it was the first crop to which controlled breeding techniques were applied.[4] In this century, most of the research has been on the improvement of varieties suitable as a source of green shelling peas for canning or market.

Our taxonomic knowledge of the species was in a confused state till 1930, when Govorov's study of the genus *Pisum* was published.[3] His survey was part of the world-wide investigations into cultivated plants begun by Vavilov. He showed the existence of six distinct species (Table 1) in the genus *Pisum*, all of which have some features of agricultural interest. *P. sativum* is made up of three sub-species, each of which comprises a number of groups of varieties with certain characters (a gene-complex) in common. Each of these groups (proles) occur within a more or less distinct geographical area.

Table 1.
Govorov's Subdivision of the Genus Pisum.

Genus *Pisum*.			
Species ..	1. *formosum*. 4. *abyssinicum*.	2. *fulvum*. 5. *humile*.	3. *elatius*. 6. *sativum*.
Subspecies	*asiaticum*.	*transcaucasicum*.	*commune*.
Proles (geographical groups of varieties)	*syriacum*. *persicum*. *ægyptiacum*. *indicum*. *afghanicum*. *heraticum*. *badakhshanicum*. *pseudoasiaticum*.	*badurianicum*. *wolgense*.	*æthiopicum*. *oreoanatolicum*. *mongolicum*. *sibiricum*. *europæum*. *chivense*. *japonicum*. *mediterraneum*.

Members of the various subspecies of *P. sativum* and of the other species have been successfully crossed, and Govorov considers the genetical results indicate the probable origin of this species from *P. fulvum* and *P. elatius*. More importantly, such crosses have shown the possibility of new combinations of genes resulting in agriculturally valuable characters. Characters of obvious importance for the Australian environment are capacity to flower and set seed rapidly (" earliness " or " short growing season "), drought resistance, and pod formation at a height convenient for mechanical harvesting. Each of these has been noted to be characteristic of one or more proles and it may be possible to combine them in the one variety.

Govorov discards the time-honoured but artificial species, *P. hortense*, which was used to contain the green shelling varieties. He does this on the ground that such varieties differ from the field peas of *P. sativum* in only one or two characters and are cross fertile with them. The subdivision of the species according to their commercial purpose is, however, still useful:

(*a*) Field peas—for grain, hay and green manure. These have smooth or dimpled seed with coloured or white flowers.

(*b*) Vegetable peas—pods picked in immature stage, shelled for green peas or eaten whole (sugar peas). These usually have wrinkled seeds and white flowers. Associated with the wrinkled seed is a higher sugar content at the immature stage, but also a higher susceptibility to parasitic soil fungi, and this increases the costs of production and thus reduces its use as an animal fodder.

Status of the Crop in Australia and New Zealand.

Table 2 gives the production of peas as grain in the Australian States and in New Zealand.

TABLE 2.

Production of Peas as Dry Grain in Australia and New Zealand.

Pre-war Average in Thousand Bushels.

		N.Z.	Tas.	Vic.	S.A.	W.A.	Total.
Green cotyledons.	Blues	21	190	—	—	—	211
Yellow cotyledons	Duns	—	—	120	50	—	170
	Partridge	280	180	—	—	—	460
	White Brunswick ..	—	—	—	150	34	184
	White Ivory and White Victoria	20	—	—	—	—	20

In Australia, interest in the species has been sporadic and mainly in market garden varieties, and it is only since the war began that canning and packeting varieties have become important. An annual average of 700,000 bushels of dry grain has been produced over the 15 years ending 1939, and this has been used by humans or animals and for green manuring crops in orchards and market gardens. Only in South Australia has the crop become an important component of the rotation in the wetter part of the wheat belt, where at least 17 inches of rain per year is usual, because a suitably early variety is available which can be threshed for grain or fed off dry according to the price of peas at the time. A new variety, Collegian, was produced at Roseworthy College in 1940 and combines the same length of growing season as White Brunswick, the standard second early variety, with higher yield and less tendency to shed seeds at harvesting.

In 1944, Calder[1] outlined the place of *Pisum sativum* in New Zealand agriculture, emphasizing the interest in market garden peas and in the dry pea used for packeting (seed with green cotyledons) or splitting. A new variety for each of these uses has been produced by the Department of Scientific and Industrial Research, and some research done on the inheritance of dimpled and smooth seedcoats, the characters which affect the ease of splitting of the dry pea.

Research Programme.

Expansion of the use of the species as a crop for grain or dry forage depends on (*a*) the availability of varieties with a shorter growing season to escape both drought and such insect pests as pea weevil in Western Australia and corn earworm in all the States, with higher and more reliable yields than those at present grown and with increased nutritive qualities, and also on (*b*) an increased appreciation of the potentialities of the crop.

Length of Growing Season. Table 3 shows the main varieties grown in Australia and New Zealand grouped according to length of growing season and use. The varieties, Alaska (the earliest canning pea in North America) and Mansholts (the earliest field pea in England), can also be grouped in the " 1st early " section and may be useful experimentally, though their yields are very low.

TABLE 3.

Commercial Varieties in Australia and New Zealand. Length of Growing Season.

		1st Early.	2nd Early.	Mid.	Late.
Pisum sativum.	Field Types.		White Victoria. White Brunswick. Collegian. Dutch Blue (G.).	Dun. Blackeyed Susan. White Ivory. Tasmanian Blue (G.). Harrison's Glory (G.).	Partridge.
	Vegetable Types.	Massey. (G., Y.).	Greenfeast. (G., Y.).		

Colour of cotyledons, Green (G) or Yellow (Y.).

The late and mid-season varieties of peas grow best in areas with a growing season of over 7·5 months ; attention to increased yield and resistance to leaf and stem diseases in these forms should improve their value for the districts with well distributed rainfall, but the main wheat areas in southern Australia have a growing season of 5 to 7·5 months and for these no variety in either late or mid-season group will be completely satisfactory. The " 2nd early " group of peas grow best in areas with a growing season of about 7 months and thus are a reliable crop only in the wetter part of the wheat belt. So far no 1st early variety of field pea has been produced which will grow and yield better than those of the " 2nd early " group when cultivated in the regions of low rainfall which occur in the wheat belt. A successful variety must be able to mature seed early or continue flowering over a long period with the capacity for ripening seed if later rains occur. Such capacities may exist in some of the Asiatic varieties.

Some information on the factors controlling flowering was obtained by sowing throughout the year varieties that differ widely in length of growing season. These factors are varietal reaction, length of day, and temperature. (See Fig. 1.)

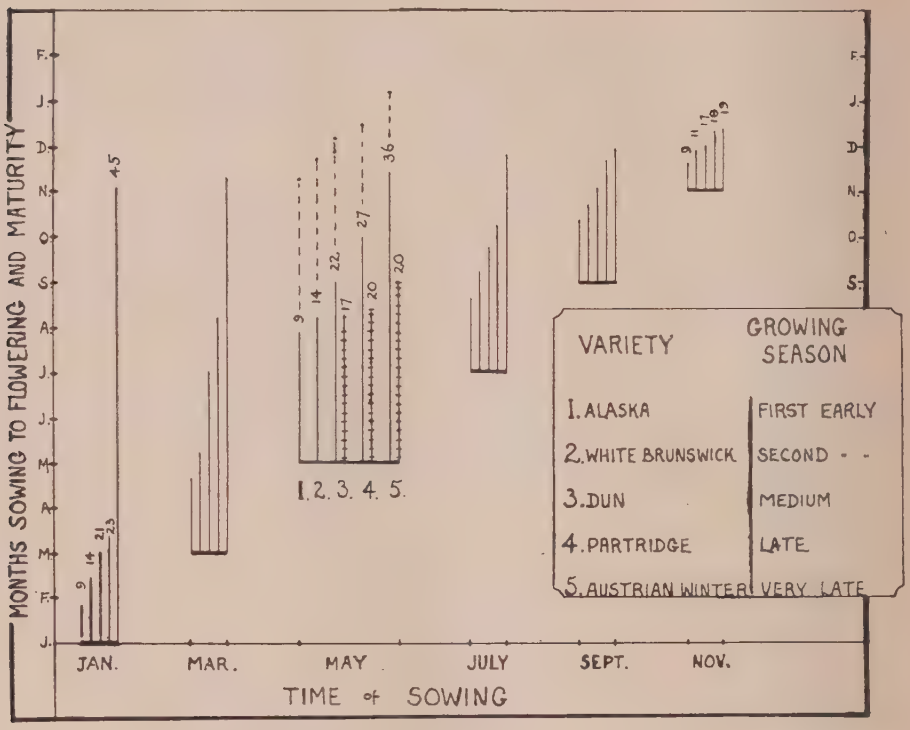

Figure 1.

Graph showing relation between time of sowing and (1) time of flowering. (2) period sowing to flowering, (3) node of first flower.

+ + + + + + shows earlier flowering of varieties when the day is artificially lengthened in winter

— — — — — — shows period from flowering to maturity.

Varietal Reaction. As with other legumes, the number of the node (counting up from the first foliage leaf) at which a pea plant begins flowering is a heritable character. It indicates the plant's flowering response to length of daylight and to temperature level. Variety 1 flowered at the ninth node whatever time it was sown during the year, whereas variety 5 flowered at node 19 when sown in November, but delayed flowering till node 45, when sown in January. It can be seen that the later the variety, the greater the range in node of first flower in sowings throughout the year.

Length of Day. Some of the plants sown in May (Fig. 1) were subjected to an artificially increased length of day. Variety 1 was unaffected, but variety 3 flowered five nodes earlier, and variety 5 sixteen nodes earlier than the controls. Thus the variety with the longest growing period showed the greatest response.

Temperature. Chilling the germinating seed of the later varieties also led to flowering at a lower node than the controls, though the difference was less than that resulting from long-day treatment.

It was concluded that a cool period and a certain length of day were necessary for the later varieties before flower primordia could be formed, but in the earliest varieties this process was uninfluenced by the range of temperature and length of day occurring over the year in southern Australia.

Temperature also affected the rate of growth of all the varieties in the same way. In Fig. 1 it can be seen that variety 1 took about three times as long to reach flowering when sown in autumn as when sown in summer.

The discovery of varieties that could form nodes quicker would be a useful contribution to the objective of increasing yield in the plant.

Seed Maturity. The time taken from flowering to seed maturity also varied with temperature. A variety maturing during the winter took about three times as long as in the summer. Comparing a range of varieties sown in autumn, the " 1st early " group took about ten weeks to ripen seed, and the latest group ripened in about six weeks. Within some of the groups certain Asiatic varieties with small seeds matured earlier than the rest and other varieties may exist with even quicker maturation.

The abscission of flower buds has been noted amongst all varieties, particularly when flowering begins, and as this may annul the advantages of early flowering in a short growing season, varieties that develop their flower buds satisfactorily under these conditions should be looked for.

Peas as a Source of Protein, Minerals and Vitamins.

In Australia, the grain of field peas is chiefly used as a protein concentrate for pigs or for sheep in the summer. Overseas it is also used for dairy cows, horses, sheep and poultry.

Seeds of the main commercial varieties were analysed in 1942 (unpub. data by J. M. Haughton) for crude protein content, and showed a range of 24-31 per cent. contrasted with the range of 10-15 per cent. for Australian wheat varieties. However Lugg[6] has shown that the protein of one variety of vegetable pea is very low in the essential amino-acid methionine, and fairly low in cystine. This low level of methionine was found to be the limiting factor for chicken-growth in recent American tests.[11]

In the human diet, the pea seed is an excellent source of iron and thiamin, and a good source of calcium as well as supplying fair amounts of vitamin A and of other members of the B complex. The human intake of thiamin could be greatly increased by a wider use of pea-meal in soups and other dishes[2] or by including sugar peas in the diet. McCrea[7] showed that thiamin concentration in the growing plant was highest in the developing pods, and the sugar type can be eaten like French beans as the fibrous layer is absent from the wall of the pod. Lugg and Weller[5] have drawn attention to the importance of sprouted peas as an emergency source of ascorbic acid. It is of interest to note that in the past when meat was scarce, pease pudding was a common food in the dietary of the people in Britain. Peas as grain are a useful source of protein and are used either as split peas in soup, or as dry packet peas which are a substitute for green peas.

There is no evidence that peas are unpalatable to animals. The slightly bitter taste noted in the raw state disappears after a few minutes' cooking of pea-meal, though it takes much longer to disappear when split peas are used.

Research is needed into the occurrence and inheritance of nutritive qualities in the various varieties. Ultimately, high nutritive quality might be combined with high yield.

Conclusion.

The few varieties grown commercially in Australia, England and America show small variation in the characters important to yield and quality. However, Govorov[3] has shown the immense range of varieties in Asia, Africa and Europe, and has found that crosses between varieties from different geographical races resulted in very diverse F2's from which unusual and useful lines have been segregated.

Such research suggests the possibility of greatly improved varieties for Australian conditions, and the urgent necessity for a wide range of material on which to build a sound breeding programme, based on genetical analyses of yield characters.

The objects of the breeding programme may be summarized as follows:

(*a*) To obtain varieties of field peas of high yielding capacity in grain and hay to cover a wide range of climate, particularly areas with less than 7·5 months growing season.

Increased production may be expected from:

(1) a type which will flower sufficiently early to enable the maximum filling of pods before drought ends the growing season;

(2) plants with a morphological structure enabling the production of the maximum number and weight of seeds (a vigorous root system, sturdy stems, basal and upper podding laterals, double pods, a high percentage of mature seeds, a high number of seeds per pod and a high number of flowering nodes).

(3) plants with resistance to soil and air dryness and to disease.

(*b*) To combine the above qualities with high levels of crude protein, essential amino acids and vitamins to increase the nutritional value of the crop.

Crossbred material is being used at present to study the inheritance of these yield characters in order to attempt their combination.

References.

1. Calder, R. A.: N.Z. Journ. Sci. and Tech. Agric., 25: 242, 1944.
2. Coulter, E. M.: Thesis for M.Agr.Sc., Melbourne University.
3. Govorov, L. I.: Flora Cult. Plants, ed. Vavilov, Part IV, Grain Legumes, 238, 1937.
4. Hedrick, U. P.: Vegetables of New York—Peas and Beans, 7, 1928.
5. Lugg, J. W. H., and Weller, R. A.: Aust. Journ. Exp. Biol. and Med. Sci., 21: 211, 1943.
6. Lugg, J. W. H., and Weller, R. A.: Aust. Journ. Exp. Biol. and Med. Sci., 22: 149, 1944.
7. McCrea, J.: Thesis for M.Agr.Sc., Melbourne University.
8. Petersen, C. F., Lampan, C. E., Bolin, D. W., and Stamberg, O. E.: Poultry Science, 23: 287, 1944.
9. Rural Reconstruction Commission (Commonwealth of Australia): 3rd Report, p. 42, 1944.
10. Waite Institute Report, 1941-42, p. 6.

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TECHNICAL NOTE

EFFECT OF TEMPERATURE AND TIME OF SOWING ON THE GROWTH OF FLAX IN THE FIELD.

During 1941 single rows of Liral Crown and Concurrent, the two varieties of flax used commercially in Australia, were planted at the Cressy Research Farm, Tasmania, each week from 3rd March to 27th October inclusive. An endeavour was made to study, under field conditions, the effect of temperature on the rate of growth, and the effect of the time of sowing on the length of the life cycle of the plants. In addition the effect of the time of sowing on the height of the plant was recorded.

The Cressy Research Farm is situated eighteen miles south of Launceston and has a climate similar to the Midland section of Tasmania. Although the rainfall (24·6 inches per annum) at Cressy is lower than that of the majority of the flax-growing districts of the State, facilities for frequent observation were available there. The soil of the area selected for the trial was of a light alluvial type with a decided slope to the south.

Notes were taken of the date the seedlings appeared above ground (brairding), the date on which the pluminal bud between the cotyledons began to open (bud burst), the date flowering commenced, the height at and date of maturity and the yields of total produce. Data for Liral Crown are given in Table 1.

Temperature and Rate of Growth.

As brairding and bud burst are two definite and easily recorded stages in the growth of flax, the period between these stages can be used as a measure of the rate of growth of young plants.

The effect of temperature on rate of early growth of Liral Crown flax is shown graphically in Figure 1. Temperature records are the average of the daily shade temperatures $\left(\frac{\text{max.}+\text{min.}}{2}\right)$ for the period between brairding and bud burst for each date of sowing.

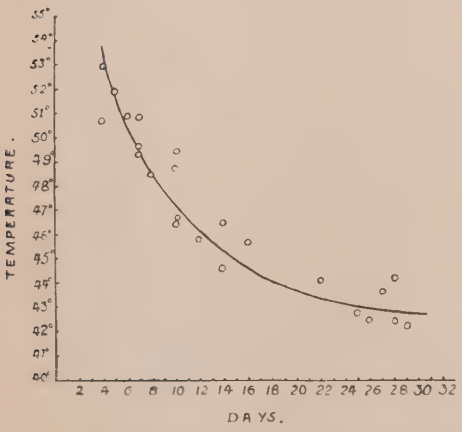

Figure 1.
Showing the effect of temperature on the rate of growth of Liral Crown flax. Rate of growth is recorded as the number of days between brairding and bud burst and temperature is the mean of the daily shade temperature $\left(\frac{\text{max.}+\text{min.}}{2}\right)$ for the period.

The length of time from brairding to bud burst varied from 29 days during July and August, when mean temperature was 42° to 43° F., to four days in late October and early November, when the mean temperature was 50° to 54° F. At a temperature of about 45° F. and less the growth of flax is very slow ; it practically ceases at 42° F., which conforms with local experience for bulk-sown flax crops.

TABLE 1.

The Effect of Date of Sowing and Temperature on the Growth Stage of Liral Crown Flax.

Row No.	Date Sown.	Brairding.	Bud Burst.	Flowering.	Maturity.	Brairding to Bud Burst. Days.	Mean Temp. °F.
1	3/3	24/3		16/10	15/12		
2	10/3	24/3		16/10	15/12		
3	17/3	26/3		16/10	15/12		
4	24/3	2/4		16/10	15/12		
5	31/3	2/5		30/10	23/12		
6	7/4	2/5		4/11	30/12		
7	14/4	2/5		4/11	30/12		
8	21/4	9/5		4/11	30/12		
9	28/4	2/6		6/11	30/12		
10	5/5	7/6		6/11	30/12		
11	12/5	10/6		6/11	30/12		
12	19/5	15/6		6/11	5/1		
13	26/5	17/6	15/7	8/11	5/1	28	44·2
14	3/6	25/6	22/7	8/11	5/1	27	43·7
15	10/6	2/7	28/7	10/11	5/1	26	42·5
16	17/6	8/7	6/8	10/11	5/1	29	42·3
17	23/6	16/7	13/8	12/11	13/1	28	42·5
18	30/6	24/7	18/8	15/11	13/1	25	42·8
19	7/7	1/8	23/8	15/11	13/1	22	44·1
20	14/7	13/8	27/8	16/11	13/1	14	44·6
21	21/7	16/8	1/9	17/11	13/1	16	45·7
22	28/7	21/8	4/9	18/11	13/1	14	46·5
23	4/8	27/8	8/9	19/11	20/1	12	45·8
24	11/8	1/9	11/9	20/11	20/1	10	46·7
25	18/8	4/9	14/9	21/11	20/1	10	46·5
26	25/8	10/9	18/9	21/11	20/1	8	48·5
27	1/9	15/9	22/9	24/11	20/1	7	50·9
28	8/9	19/9	29/9	28/11	20/1	10	49·5
29	15/9	26/9	6/10	2/12	20/1	10	48·8
30	22/9	4/10	11/10	4/12	20/1	7	49·7
31	29/9	8/10	15/10	6/12	20/1	7	49·4
32	6/10	15/10	21/10	9/12	20/1	6	50·9
33	13/10	23/10	27/10	12/12	20/1	4	50·6
34	20/10	28/10	2/11	15/12	6/2	5	51·9
35	27/10	3/11	7/11	20/12	6/2	4	53·9

During March, April and May, the moisture content of the soil was at times not sufficient for seed germination. This is shown in Figure 2 by the variations in date of brairding of successive weekly sowings of Liral Crown. Rain fell at the time of the 3rd and 4th sowings, between the 8th and 9th sowings, and between the 12th and 13th sowings. After each rain several rows would braird at or about the same time. For example, the 1st and 2nd sowings brairded on 24th March, the 3rd on 26th March, and the 4th on 2nd April, while the 5th, 6th and 7th sowings did not braird until 2nd May after rain had fallen between the 21st and 28th April. From late May onwards the soil contained sufficient moisture for germination, and temperature then became the chief limiting factor for germination and growth.

Time of Sowing and Length of Life Cycle.

In Figure 2 and Table 1 are shown the effect of time of sowing on the stage of growth and on the length of life cycle of the varieties. The successive weekly sowings are shown above the base line in Figure 2 and the period of time from sowing to any particular stage of growth can be read from the vertical scale. As the same

scale of days is used both horizontally and vertically the date of any event can be ascertained approximately by the position of the oblique bands representing the months.

The irregularities in the flowering date line in late October were caused by rain delaying flowering and irregularities in the maturity date line were caused by summer rains delaying ripening.

There is a steady reduction in the period from sowing to maturity with successive sowings ; although the 35th row of Concurrent was sown 238 days later than the 1st row, it was only 45 days later in reaching maturity, or 295 days compared with 102 days between sowing and maturity. Similarly, the 1st Liral Crown row sown took 287 days and the 35th row 102 days to reach maturity.

Concurrent sown in March flowered and matured eight days later than Liral Crown, whereas in sowings made after 4th August there was little difference in the date of maturity of the two varieties. The difference of eight days in the date of flowering was, however, maintained approximately throughout.

Time of Sowing, Height at Maturity and Yield.

There was a gradual reduction in height of Concurrent with minor variations from 39 inches for the April sowings to 12 inches for the last sowing in October.

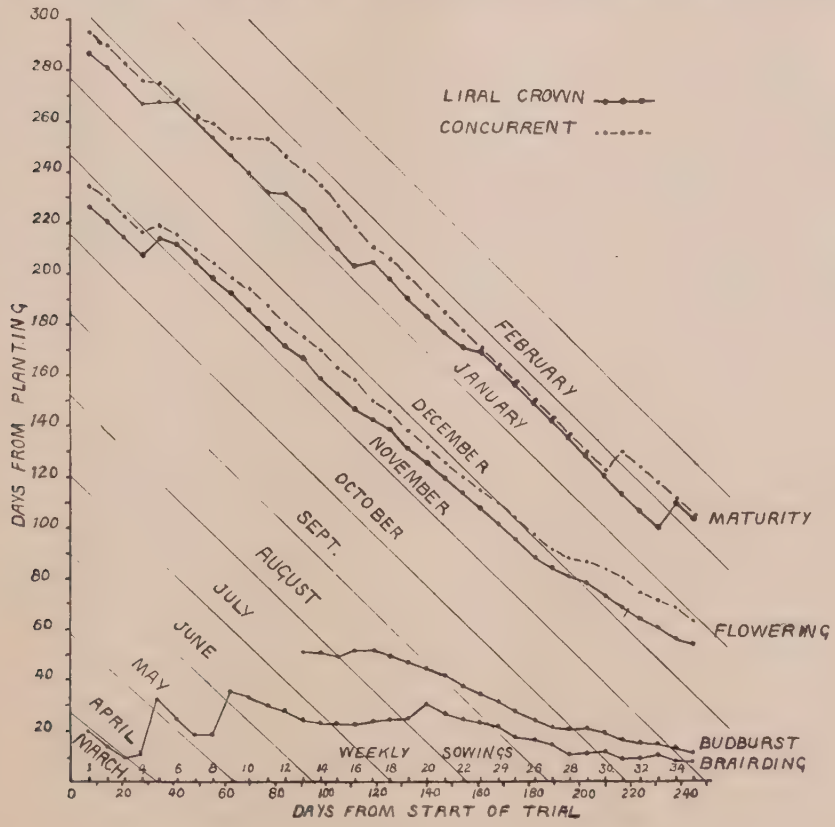

Figure 2.
Showing the effect of time of sowing on the number of days between planting and brairding, bud burst, flowering and maturity of Liral Crown and Concurrent flax.

Only the Autumn sown rows would have produced standard commercial straw of a harvested length of 27 inches. Measurements were not taken on Liral Crown because of lodging of the Autumn sown rows.

As would be expected from a trial of this type, yields of total produce from individual rows varied considerably. These variations are reduced by taking the average yield of rows sown during each month, which yields are as follows :

Month of Sowing.	Mean Yield in lbs. per Row. Concurrent.	Liral Crown.
March	3·9	2·5
April	2·4	1·6
May	2·0	1·7
June	0·7	1·5
July	0·9	1·2
August	0·9	1·6
September	0·6	1·3
October	0·2	0·5

One pound per row is equivalent to 22 cwt. per acre.

The yield response of the two varieties to time of sowing is very different. Autumn (March, April or May) sown Concurrent out-yielded Liral Crown, whereas Spring (August or September) sown Liral Crown out-yielded Concurrent.

Discussion.

A mean shade temperature of 42° F. can be accepted, at least for the conditions of this experiment, as the minimum temperature for the early growth of flax in the field. This is related to the time of sowing flax commercially because the risk of loss of seedlings is increased considerably when germination and early growth are slow. Plant stand is important in flax growing, not only for its effect on the yield of crop, but also because an untillered fine straw gives a higher percentage of fibre of higher quality than does a very coarse straw. The data presented indicate, therefore, that flax should be sown when the mean shade temperature for some weeks after sowing is expected to be above 45° F.

Sowings of Concurrent made during the Autumn months of March, April and May gave yields of total produce equivalent to 86, 53 and 44 cwt. per acre respectively, whereas later sowings yielded less than 20 cwt. per acre. Liral Crown, on the other hand, although it gave the highest yield with Autumn sowing, did not show such a marked decrease in yield as did Concurrent.

The results of this experiment suggest that flax is much more influenced by length of day than are the Spring sown cereals, and, if sown later in the Spring, it does not, with the length of day experienced in Tasmania, have time to attain reasonable height and weight before flowering begins. This aspect of flax growing, therefore, merits further study.

J. Tilt.

Department of Agriculture,
Tasmania.

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The Australian Institute of Agricultural Science

THE NEW PRESIDENT.

Dr. B. T. Dickson was installed as sixth President of the Institute at the close of the seventh General Meeting on Thursday, February 15th.

The new President has been Chief of the Division of Plant Industry of C.S.I.R. since its inception. A graduate of Queen's University, Ontario, Canada, he took post-graduate work at Cornell University, where he was appointed to the staff. He was on active service for three and a half years during the 1914-1918 war, and after the Armistice became Commandant of the First British Army School of Agriculture in France. The French Government made him a Chevalier de l'Ordre du Mérite Agricole. From France he went to McGill University and, as Professor of Economic Botany, developed a strong post-graduate school, many of his one-time students now occupying important senior positions. In 1927 he came to Australia to serve with C.S.I.R. as a Chief of Division.

His other interests cover three fields. As a member of the Executive of the Australian National Research Council, past President and Councillor of the Royal Society of Australia, and member of the Council of the Canberra University College, he helps to further science and education. The Legacy Movement and local Repatriation Committee cover the Returned Soldier field, while Rotary and local service work comprise general community interest. He was foundation President of the A.C.T. Branch and was continued in office by the Branch until 1939, when Dr. Ian Mackerras took office.

MEETINGS OF COUNCIL.

A Council meeting was held at the School of Agriculture, University of Melbourne, on 16th January, 1945.

Present.—Mr. R. A. Boyle (V.), in chair, Dr. A. E. V. Richardson (S.A.), Dr. H. C. Forster (W.A.), Mr. G. H. Vasey (N.S.W.), Mr. J. L. Provan (Q.), Mr. R. W. Prunster (A.C T.), the Honorary Treasurer, Mr. R. L. Twentyman, and the Honorary Secretary, Mr. A. J. Vasey. An apology was received from Mr. F. S. Crawford (T.).

In opening the meeting the Chairman referred briefly to the fact that the occasion was the tenth anniversary of the foundation meeting of the Institute.

The Hon. Secretary reported that good progress had been made in connection with the arrangements for the forthcoming general meeting.

The Hon. Secretary advised that the report regarding the publication of a Journal of Agricultural Science requested from the Publications Committee had been received. In view of the recommendations made in a section of this report concerning future arrangements for the publication of the Institute Journal he had added a new item to the agenda to provide for discussion of this matter.

The meeting formally elected Dr. B. T. Dickson as President of the Institute for the period ensuing from the termination of the seventh general meeting on 15th February.

The following applicants were admitted to membership :—To Corporate Membership : H. E. Sundstrom (N.S.W.) ; to Student Membership : Miss E. M. Meldrum (N.S.W.), F. G. Jarrett, L. M. Ward.

The following inter-branch transfers were received and noted : E. A. Cornish, Vic. to S.A. ; R. Roe, A.C.T. to Queensland ; A. B. Cashmore, W.A. to A.C.T.

A motion that it be a recommendation to principal delegates that the Branch rebate for the year ended 31st December, 1944, be paid at the rate of 5*s*. 6*d*. per financial corporate member or member on war service was carried.

As this was the last meeting of the Proxy Council in Melbourne prior to the transfer of the office of management to Sydney, the meeting decided that votes of thanks should be recorded to the Institute's executive officers, Mr. R. L. Twentyman and Mr. A. J. Vasey, in appreciation of their excellent work over the past ten years, to Professor Wadham for his kindness in making the School of Agriculture available free of cost for meetings of the Proxy Council over the past decade, and to Mr. R. A. Boyle (V.) for his services as Chairman of the Proxy Council during 1944.

A Council meeting was held at the School of Agriculture, The University, Melbourne, on 12th February, 1945.

Present.—The President, Prof. G. A. Currie (in chair), Mr. C. R. Von Stieglitz (Q.), Dr. E. T. Edwards (N.S.W.), Dr. C. Barnard (A.C.T.), Mr. R. A. Boyle (V.), Mr. F. W. Hicks (T.), Mr. J. K. Taylor (S.A.), Dr. E. J. Underwood (W.A.), the Hon. Treasurer, Mr. R. L. Twentyman, and the Hon. Secretary, Mr. A. J. Vasey. There were also present by invitation the following members of the Proxy Council: Mr. J. L. Provan (Q.), Mr. G. H. Vasey (N.S.W.), Mr. R. W. Prunster (A.C.T.), Dr. H. C. Forster (W.A.), Dr. F. T. Bowman, Hon. Secretary-elect, and Mr. N. C. Lloyd, Business Manager of the Journal. Apologies were received from Dr. A. E. V. Richardson (S.A.) and Mr. F. S. Crawford (T.).

The following applicants, details of whose qualifications were read to the meeting, and which had been approved by the Qualifications Committee, were admitted to corporate membership: R. Dinning (Tas.), R. L. Reid, B. Horowitz, A. L. C. Davidson (N.S.W.), P. A. M. Bell, S. C. Denham, K. M. Fraser (Vic.), D. S. Thompson (S.A.).

The payment of a Branch rebate for the year ended 31st December, 1944, at the rate of 5*s.* 6*d*, per financial corporate member and member on war service, was approved.

The transfers of T. Gould and J. L. Gillespie from Victoria to New South Wales were recorded.

It was decided that, in recognition of the services rendered by retiring office-bearers Mr. A. J. Vasey, retiring Hon. General Secretary, should be elected an Honorary Life Member of the Institute, and that the sum of £15 be contributed from Institute funds to the presentation to be made to Mr. Vasey, and that Mr. R. L. Twentyman, retiring Hon. General Treasurer, should be presented with £10 8*s.*, in the form of 13 £1 war savings certificates, and that Dr. N. S. Noble, retiring Business Manager of the Journal, should be presented with £6 8*s.*, in the form of eight war savings certificates.

A Council meeting was held at the School of Agriculture, The University, Melbourne, on 16th February, 1945.

Present.—The President, Dr. B. T. Dickson (in chair), Prof. G. A. Currie (W.A.), Mr. C. R. von Stieglitz (Q.), Dr. E. T. Edwards (N.S.W.), Dr. C. Barnard (A.C.T.), Mr. R. A. Boyle (V.), Mr. N. H. White (Tas.), Mr. H. G. Andrewartha (S.A.) and the Honorary Secretary, Mr. A. J. Vasey. There were also present by invitation Dr. F. T. Bowman, Hon. Secretary-elect, Mr. F. C. McCleery, Hon. Treasurer-elect, Mr. N. C. Lloyd, Business Manager of Journal, Mr. W. M. Willoughby (A.C.T.) and Mr. R. W. Prunster (A.C.T.). An apology was received from the Hon. Treasurer, Mr. R. L. Twentyman.

The following office-bearers were appointed:—Institute Executive Officers: Hon. General Secretary, Dr. F. T. Bowman (to take office as from 26th February); Hon. General Treasurer, Mr. F. C. McCleery (date of taking office to be arranged). Journal Officers: In view of the recommendation of the Publications Committee that the Journal Staff should be provided by a different branch from that responsible for the office of management, and the invitation, approved by the general meeting, to the S.A. Branch to assume responsibility for the Journal, the following Journal officers were appointed to act pending completion of arrangements for such change: Editor of Journal, Dr. Lilian Fraser; Business Manager of Journal, Mr. N. C. Lloyd; Publications Committee (to act with Editor and Business Manager), Dr. H. J. Hynes (chairman), Dr. E. T. Edwards, Mr. I. A. Watson, Mr. W. Poggendorf.

A recommendation was received from Professor J. A. Prescott, Convener of the Qualifications Committee, that it was undesirable that responsibility for the provision of this committee should remain with one branch indefinitely, and that the present was an appropriate time for a change. This recommendation was accepted and it was decided to request the Victorian Branch to provide the Committee and to submit three names for approval by Council as members of the Committee. In the meantime the present members of the Qualifications Committee, Professor J. A. Prescott, Dr. A. R. Callaghan and Mr. Rowland Hill, are to be requested to continue to act until their successors are appointed.

It was resolved that Branches give to delegates and delegates transmit to proxies at Proxy Council meetings as full powers of compromise as possible, unless definite and specific instructions be given to the contrary. It was further resolved that Proxy Council meetings should continue to be held at intervals of two months.

SEVENTH GENERAL MEETING.

Perhaps the most common expression of opinion about the Seventh General Meeting had regard to its successful and enthusiastic nature. The programme given in the last issue of this Journal was followed with minor variations brought about chiefly by the need to hold sessions solely for the consideration of resolutions. Council meetings were held immediately prior to and after the general meeting, and are reported elsewhere in this issue.

At the highly successful official dinner, which was held at Union House on the 12th February all visiting delegates were the guests of the Victorian Branch. Professor Currie presided, and guest speakers included Mr. F. J. S. Wise of the Rural Reconstruction Commission, who addressed the gathering on the open spaces of Australia, and Mr. Hutton, of the British Food Mission, who spoke on the war-time provision of food commodities to England. Advantage was taken of this function to make a presentation to Mr. J. A. Vasey as a token of appreciation for his ten-year term of service as General Secretary to the Institute.

Tuesday, 13th February, was devoted to Institute business, and was followed at night by the address of the retiring President, Professor Currie, who spoke on " Agricultural Education—for What ", the text of which appears in this issue of the Journal.

Wednesday, 14th, and Thursday, 15th, were occupied in technical discussions, divided into four sessions, at which the formal speakers were as follows :

Session 1—Agricultural Policy in the Post War Period—General Considerations : S. M. Wadham, E. J. Breakwell, C. M. Donald.

Session 2—Agricultural Research to meet the demands of Post War Agriculture : B. T. Dickson, W. Hartley, H. C. Trumble.

Section 3—The Organization of Agricultural Extension Services in the Post War Period : H. Parry Brown, H. G. Andrewartha, T. H. Atkinson.

Session 4—The Provision of Personnel : the Coordination and Structure of University Courses in Agriculture, Undergraduate and Post Graduate : H. C. Trumble, B. T. Dickson.

At each session the subject was thrown open to discussion and the resolutions arising were examined and debated prior to the commencement of the ensuing session. It is intended to publish much of the material of these sessions in future issues of the Journal. The resolutions are given at length below.

Towards the close of the fourth session, The President expressed thanks to the Resolutions Committee and the various office-bearers, and a presentation was made to Dr. N. S. Noble, received on his behalf by Dr. F. T. Bowman, for his seven years' service as Business Manager of the Journal. Earlier in the proceedings a presentation was made to Mr. R. L. Twentyman for his long service as General Treasurer. The meeting was terminated by the installation of the incoming President, Dr. B. T. Dickson.

Resolutions.

Reports were received on Agenda items 1 to 4 as published in the last issue of the Journal. Resolutions arising out of Agenda items 5 to 7 were as follows :

Agenda Item 5.

(*a*) *Policy of the Institute in relation to " Objects " listed in Memorandum of Association.*

RESOLVED (1) That this meeting accepts the principle of the Institute's sponsoring conferences of technical workers in the various fields of Agricultural Science, and that Council be asked to take steps to convene such conferences from time to time.

(2) That this meeting recommends Council to follow a vigorous policy of publicity and representation of its views to interested Institutions, Governments and Government Departments, and to this end urges it to reconsider the submissions of the several Branches on the subject of Institute policy.

(*b*) *Functioning of Proxy Council.*

RESOLVED That this meeting directs Council to investigate the question of freedom of decision by Delegates and Proxies, and that Council should consider, with a view to adoption, the proposals of the South Australian and A.C.T. Branches under this heading, reading as follows : (1) Proxy Council should meet on a nominated regular date, e.g. the first Monday in February and every succeeding second month, i.e. six meetings a year.

(2) Each Branch committee to meet in the third week following Proxy Council meeting to consider the minutes of the Proxy Council meeting.

(3) All motions and amendments put forward by branches for consideration by Council to be in the hands of the Secretary three weeks before the date of the Council meeting. The Agenda for the meeting, including such motions, to be distributed to delegates at least two weeks before the meeting. Branches proposing motions and amendments should forward with them six copies of a supporting statement for distribution to delegates with the Agenda.

(4) The motion thus brought forward at any Council meeting shall be voted on at the following meeting, unless the Secretary shall have received from a Principal Delegate in the interim either a written request for deferment, or a notice of an amendment.

(5) The vote on the motion and amendments must be taken at latest at the second Council meeting subsequent to the meeting at which the original motion was submitted.

(*c*) *Rotation of Office of Management.*

RESOLVED That this meeting adopts the principle of Rotation of the Office of Management between the Branches and determines that the Office of Management shall normally remain in one centre for a period of four years.

(*d*) *Method of Election of President.*

RESOLVED That this Meeting is of the opinion that the Principal Delegates should if possible, by communication among themselves, agree upon a single nomination for the post of President; and reaffirms a previous decision that Council should frame By-Laws to fix dates for the issue to Delegates of the list of eligible candidates for the submission to Council of the nomination or nominations.

(*e*) *Returned Soldier Preference.*

RESOLVED That this Institute believes:

(1) That the best interests of Agriculture and the Community will be served if merit is regarded as the primary factor in making professional appointments and promotions.

(2) That other things being equal, preference should be given to returned men or women.

(3) That no disability should be suffered by any returned man or woman on account of his or her war service, and that time lost from professional work by such persons should be counted as professional service by employing authorities in making appointments and promotions.

(4) That every effort should be made to provide opportunities, at the public expense, for returned service men and women to receive such professional training and instruction as they desire and show an aptitude for and which they missed as a result of their war services.

That this Meeting further resolves to send this resolution to the Commonwealth Government as a matter of urgency, and to send a copy of the resolutions and the discussion leading up to it, to all members on service whose addresses can be traced.

(*f*) *Salaries and Status.*

RESOLVED That this Institute considers that the minimum scale of classifications and salaries for the employment and payment of professional agricultural workers should be in accordance with the following table and addenda, and asks Messrs. Forster and Vasey to redraft their submission accordingly.

Class I.—Extension and Investigation Officers. Starting minimum salaries at adult age:

Dip.Agr.	£300 p.a.
B.Sc. (Pass)	£350 p.a.
B.Agr.Sc. (Pass), B.Sc. (Hons.)	£375 p.a.
B.Agr.Sc. (Hons.), M.Agr.Sc.	£400 p.a.

thence to a maximum of £550 with automatic annual increments averaging not less than £25.

Class II.—Extension and Investigation Officers.

Range £575-£700 by automatic annual increments averaging not less than £25.

Class III.—Officers in charge of sections and specialist officers.

Range £800-£1,000 by discretionary increments.

Class IV.—Heads of Divisions.

Range £1,000-£1,250 by discretionary increments.

Class V.—Technical Heads of Departments and Institutions.

Range £1,500-£2,000 by discretionary increments.

Addenda 1. Where a probationary period exists, it should not exceed two years, thereafter permanent appointments should be made.

2. Admission of officers to Class II should be discretionary.

3. There shall be equal pay for male and female workers engaged on equivalent work.

4. The titles given to the various classes of work listed above shall be taken to include equivalent titles as used by various Departments and Institutions.

Notes.—(1) The salaries are based on the Commonwealth adult basic wage at 30.6.1939.

(2) Starting salaries go up by £25 for each additional year of training.

It was further resolved that this resolution be conveyed to the Branches for use by them in consultations with local employers; that it be used by Council in consultation with Commonwealth Departments and Institutions; and that it be sent forthwith to the Rural Reconstruction Commission.

(*g*) *Publication of an Australian Journal of Agricultural Research.*

RESOLVED That this Meeting directs Council to investigate and report on the following matters: (1) The proposal that an Australian Journal of Agricultural Research should be published.

(2) The need for and provision of an abstracting service for Agricultural Scientists.

(*h*) *Qualifications for Membership.*

RESOLVED That this Meeting has confidence in the present standard adopted in the interpretation of Article 4 relating to Admission of Members, and that there be no relaxation or tightening of interpretation, and that Council draw the attention of the incoming Qualifications Committee to the proposals of the A.C.T. Branch under this heading, namely,

(1) The Qualifications Committee continue to act in an advisory capacity.

(2) The Qualifications Committee should furnish a detailed report annually as previously requested by the A.C.T. Branch.

(3) The Qualifications Committee should be composed of three members from one branch ; one of the members to retire each two years ; and the location of the Qualifications Committee should be changed at the same time as the office of management.

(4) When the Qualifications Committee is reconstituted in a new State two members of the previous Committee to be available for consultation if necessary.

(*i*) *Provision for Life Membership.*

RESOLVED That at the next General Meeting a motion be presented altering Article 10 to provide specifically for the conferring of Honorary Life Membership.

(*j*) *New Article* 29 (*a*) *re Publication.*

As the notice of Motion for the insertion of this new Article carried the signatures of eight corporate members instead of ten, as required by Article 70, the Chairman ruled, on a point of order raised, that discussion on this item could not take place.

(*k*) *Australian Institute of Agricultural Science Journal ; Future Arrangements for Publication.*

RESOLVED That this Meeting accepts the recommendation of the Publications Committee that in the best interests of the Institute the Journal be conducted by a different Branch from that holding the Office of Management ; and invites the South Australian Branch to accept the task of conducting the Institute Journal.

Agenda Item 6.

The following resolutions arose from the Technical Discussions listed under this item :

Session I.—" Agricultural Policy in the Post War Period—General Considerations."

RESOLVED (1) That this Institute recognizes that agricultural production policies of the Commonwealth and State Governments should be co-ordinated in order to meet the needs of post-war agriculture.

(2) That this Institute recognizes the need for an all Australian agricultural policy, and believes that this policy can best be achieved by a full-time and competently staffed Commonwealth organization which recognizes the State's responsibilities and rights as well as the Commonwealth's responsibilities, the latter being especially important in matters of overseas trade.

(3) While recognizing that this must involve employment of trained technical officers by the Commonwealth, and while recognizing that the chief source of these officers is existing Commonwealth and State Departments, the Institute stresses the need for the release by existing Departments of suitable officers for this work.

(4) That the Commonwealth Government be asked to arrange suitable conditions of employment, salaries and superannuation, including some means of transference of superannuation rights, to facilitate the transfer of officers to the Commonwealth Public Service from other Government Departments and Institutions.

Session II.—" Agricultural Research to meet the demands of Post War Agriculture."

RESOLVED That this Institute is of opinion that Agricultural Research in Australia is less effective than it might be because of insufficient co-ordination between the various research authorities.

Sessions III and IV.—" The Organization of Agricultural Extension Services in the Post War Period " and " The Provision of Personnel ; the Co-ordination and Structure of University Courses in Agriculture, Undergraduate and Post Graduate."

RESOLVED That this General Meeting refers the following matters to Council with the suggestion that some of them might be referred to the particular Branches for group discussion and report back to Council ; some of these may be reportable in a form suitable for submission to authorities as representing the Institute's views, and others may be referred to the next General Meeting.

(1) Tropical Agricultural College in north Australia.
(2) Tropical Agricultural Research Station in north Australia serving also Papua and New Guinea.
(3) Regional Laboratories, as centres of research and extension.
(4) Rural Sociology.
(5) Women's extension service.
(6) Agricultural Engineering.
(7) Education in Rural Areas.
(8) Agricultural Education.
    (*a*) Degree in Agricultural Education.
    (*b*) Three years Science Course within Faculty of Agriculture, leading to courses in Education.
    (*c*) Concession to Agricultural Science Diplomatists entitling them to matriculate and enter for University course in Education.
    (*d*) Grants for Scholarships for students doing six-year course, Agricultural Science plus Diploma of Education.
    (*e*) Specific University training in Extension methods.

Agenda Item 7.

Date of Next General Meeting.

RESOLVED That should a Meeting of the Australian and New Zealand Association for the Advancement of Science be held in Adelaide in August, 1946, as reported, arrangements should be made for a General Meeting of the Institute to be held in Adelaide at the same time. However, should no meeting of the Australian and New Zealand Association for the Advancement of Science be held at this place and time, an independent General Meeting of the Institute should be held not later than the earlier months of 1947, at a place to be fixed.

MEETINGS OF BRANCHES.

Queensland Branch.

A general meeting on 11th December was addressed by Mr. A. F. Bell, a member of the Bureau of Investigation, under the Land and Water Resources Development Act, on observations made during a recent tour of the irrigation settlements in Victoria and New South Wales. In concluding, the speaker stated that irrigation development in Queensland cannot be regarded with a high degree of optimism, especially in the south-east where there is a shortage of dam sites and water is scarce. In the north, where the rivers are larger, surface waters offer more hope and some diversion to inland areas from the coastal streams may be possible, although it is considered that schemes such as the Bradfield are impracticable. Irrigation will probably have to be used primarily as a stabilizing factor and not for the purpose of expanding production. The demand for fodder and livestock should be such that irrigation would be used largely for fodder production. Underground water supplies will have to be investigated more fully and the Lockyer Valley is now being examined ; there 250 pumps are operating on wells and 350 on open water, irrigating a total of 11,000 acres.

South Australian Branch.

The third meeting in the series " The Use of Land Resources " was held on 17th November. Professor J. A. Prescott spoke on " Soil surveys as a basis for the selection of new areas " ; Professor H. C. Trumble on " The investigation of soil fertility problems " ; and Mr. R. Hill on " The practical aspects of land development ". These addresses have been published in the *South Australian Journal of Agriculture*, Vol. 48, No. 5, p. 191.

A general meeting was held on 19th January when matters of Institute business were discussed to enable a branch opinion to be formulated for submission to the forthcoming general meeting of the Institute.

Mr. Woodroffe has been appointed Hon. Treasurer to the Branch to succeed Dr. Piper, who has recently resigned.

Current Notes and News

Land Tenures in Queensland.

At a general meeting of the Queensland Branch on 15th September, Mr. J. L. Callaghan, a member of the Queensland Land Court, presented a most interesting address on land tenures in that State.

After briefly tracing the history of systems in various parts of the world, the speaker went on to deal with Queensland, which prior to separation in 1859, was the northern district of New South Wales. The country north to the Fitzroy and westwards to the Darling Downs, and the Burnett River was occupied by squatters' runs held under Imperial and N.S.W. ordinances, and was legally known as the " settled districts ". For many years after separation the history of land legislation was the history of conflicts between the squatters, the town party, and the immigrant element. At first the squatters' interests prevailed, but as the country and labour interests fused the squatters were put on the defensive, first in the settled districts and later in the outer districts.

The Agricultural Reserves Act of 1860 was the first serious attack on the squatters. It provided for the selection of up to 100,000 acres in blocks of 320 acres or less in the settled districts. In 1863 and 1865 the squatters retaliated by imposing improvement conditions on settlers. Conditional purchase remained the basis of land settlement for 50 years.

The first Consolidated Land Act (1868) was a definite forward step in land settlement. It provided for (*a*) appointment of a Land Commission and rangers, (*b*) resumption from pastoral holdings, (*c*) area restriction, (*d*) 10-year grazing farm selection, (*e*) effective occupation, (*f*) improvement conditions, (*g*) penalties for evasion. The third Consolidated Land Act (1884) embodied several new principles : (*a*) constitution of Land Courts, (*b*) fixing of rents and compensations, (*c*) compensation for resumption by new leases of remainder of holding, (*d*) selection of agricultural and grazing farms by ballot.

Early in the present century saw the beginnings of the move towards closer settlement of land served by State transport facilities. By 1908 Land Resumption and Closer Settlement Acts had been passed. In 1908 perpetual lease selection was introduced and in 1909 group settlement became a feature of land legislation. The Consolidated Land Act of 1910 marked the establishment of close settlement as the policy for land capable of intense use. Subsequent legislation culminated in the Land and Water Resources Development Act of 1943.

The types of tenures operating in respect of Crown land were outlined by Mr. Callaghan as follows :

I. *Pastoral Tenures.*
   1. Pastoral Holdings : These are limited as to term—maximum 30 years—but no conditions are imposed.
   2. Preferential Pastoral Leases : To accommodate the smaller man willing to live on the property. They are limited as to area and certain conditions are imposed.
   3. Pastoral Development Holdings : Lease up to 40 years, subject to lessee undertaking developmental work to the extent of some thousands of pounds.
   4. Stud Holdings : Another form of concession under the Pastoral Holdings system.
   5. Occupation Licences : Granted on a yearly basis without conditions.

II. *Selection Tenures.*
   A. Grazing : Limited term—up to 28 years.
      1. Grazing Homesteads : Lessee has to reside personally for seven years and then occupy it. If he sells the buyer has to reside for five years.
      2. Development Grazing Homesteads : Selector has to spend money on netting, water, etc.
   B. Agricultural, Grazing Farm and Dairying :
      1. Perpetual Lease Selections : These are little different from freehold. They are transferable and are transmissible on death. No restrictions on use are imposed.
      2. Prickly Pear Selections : Variation of Perpetual Lease Selection. Holder must take action against pear.
      3. Prickly Pear Development Selections : With the release of land from pear by *Cactoblastis*, conditions were imposed on selection. Lessee to develop half in the first five years, provide water and fence.

Corrigendum.

On p. 155 of Vol. 10, No. 4, of this journal, Table 1, Column 6, should read as follows :

Total.
22
20
15
8
6
4
75

Book Reviews

ADVANCES IN GRASSLAND HUSBANDRY AND FODDER PRODUCTION.

(*Imperial Bureau of Pastures and Forage Crops, Bulletin* 32, 1944. *Price* 4*s. sterling.*

This is a collection of papers of the kind previously published in Herbage Reviews.

A discussion by D. Meredith, on a National Pasture Policy for the Union of South Africa, will be of special interest to Australians, for the problems of veldt management so well described by the author should apply equally well to much of this country. The importance of adequate fencing, and of supplying soil nitrogen will be readily admitted here, but the author's vision that wide-scale application of nitrogenous fertilizers, to double the stocking rate of land at present carrying the equivalent of one cattle beast to nine acres, might be made possible by their cheaper production, will be received with some caution.

The summary of Canadian achievements under the Prairie Farm Rehabilitation Act touches on problems now facing this country, and an article by D. Brown on *The Herbage Seed Position in the United States of America* conveys much information and perhaps a warning to those concerned with revegetation of eroded lands. The problems of soil erosion are further dealt with in short reviews of articles from Brazil and Argentina.

The section of W. M. Hamilton's *Survey of the Dairy Industry in New Zealand* which deals with pasture development is printed in full. Amongst much of interest, it is surprising to read of a country so closely associated with the concept of improved strains that " One is

forced to the conclusion that to date the improved strains of pasture plants have made little direct contribution to increased carrying capacity in the dairying districts, and at the present rate of replacement of pastures (approximately 1·2 per cent. per annum) it will take many years to obtain measurable benefits". New Zealand is also represented by a review of *Trials of Herbage Plants at Lincoln.*

The scientific work of the late Captain P. D. Williams is recorded in a short note by Professor T. J. Jenkin, and this is accompanied by a bibliography of his published works.

Other contributions include reviews of *Field Experiments at Potchefstroom* and *Irrigation of Lucerne in U.S.S.R,* a report on *Hill Sheep Farming in Great Britain,* a list of *Fodder Trees in Madras,* a note on oil from *Trifolium subterraneum,* and a review of a description of *The Agriculture of Szechwan.*

C. S. CHRISTIAN.

PROPAGATION BY CUTTINGS AND LAYERS. RECENT WORK AND ITS APPLICATION, WITH SPECIAL REFERENCE TO POME AND STONE FRUITS, by R. J. Garner.

(*Imperial Bureau of Horticulture and Plant Crops* (*Tech. Com.* 14, 79 *pages*). *East Malling,* 1944. *Price* 3*s.* 6*d. sterling.*)

This publication is another of the valuable reviews of horticultural subjects produced by the Imperial Bureau of Horticulture and Plantation Crops. The author is the propagator at East Malling Research Station, mecca of research in vegetative propagation of deciduous fruits.

At a time when some forethought is being given to the means of reconstructing fruit plantations in the war-scorched countries and when also there is, it is stated, an increasing demand for clonal rootstocks in other countries, the publication of this volume is most opportune. It deals essentially with the technique of vegetative propagation, the discussion in each of the main sections following the order in which material is handled by the propagator.

The first part consists of a review of literature on various practical factors in propagation by (*a*) cuttings and (*b*) layers, from the selection of the material to its planting and subsequent treatment. In the space of 35 pages an extraordinary number of factors affecting propagation are brought under review, the whole being a valuable order of reference for many years to come. It is evident that a very wide survey of the literature was necessary in order to select for review some 250 papers by 200 investigators, having a direct bearing on the art of propagation by these methods.

The second part is a clear exposition of the methods used at East Malling to raise fruit plants by cuttings (hardwood, softwood, leaf-bud and root cuttings), and by layers (etiolation, stooling and tip layering). This section is aptly illustrated by line drawings carefully considered and executed.

A final section of a couple of pages contains many suggestive thoughts on future research. A five-page index completes the publication.

F. T. BOWMAN.

Personal Notes

Dr. A. R. Callaghan, Principal of Roseworthy Agricultural College, South Australia, was awarded the C.M.G. in the New Year Honours List.

Mr. Robert Smith of the Division of Soils, Council for Scientific and Industrial Research, has been transferred from South Australia to Western Australia to undertake soil surveys of areas proposed to the Rural Reconstruction Commission. His headquarters will be at the Institute of Agriculture, University of Western Australia.

Mr. B. E. Butler has been released from the R.A.A.F. and has returned to the Division of Soils, Council for Scientific and Industrial Research, Adelaide.

Mr. R. L. Crocker has resigned from the Division of Soils, Council for Scientific and Industrial Research, Adelaide, and is joining the Waite Institute staff as Grassland Ecologist.

Mr. G. M. E. Mayo, a student member, has been released from the Army and is continuing his studies in the Agricultural Science Faculty, University of Adelaide.

Major R. N. McCulloch (A.I.F.), New South Wales Branch, is reported to have done outstanding work on scrub typhus in the tropics with a mite repellant.

Squadron Leader R. B. Duncan (R.A.A.F.), New South Wales Branch, still holds the Sydney University Pawlett Scholarship awarded in 1941, and his release from the R.A.A.F. having been approved, he is proceeding to advanced statistical work in the United States of America.

Lieut. K. D. McLachlan, New South Wales Branch, has been released from the A.I.F. and has joined the research staff of the Department of Post-War Reconstruction.

J. O. Smith, student member, New South Wales Branch, who was a prisoner of war in Malaya with the 8th Division, A.I.F., and was recently rescued, will continue his studies at the Sydney University in 1945.

J. W. Gamage, New South Wales Branch, has been transferred from Orange High School to Sydney Technical College to lecture in Biology.